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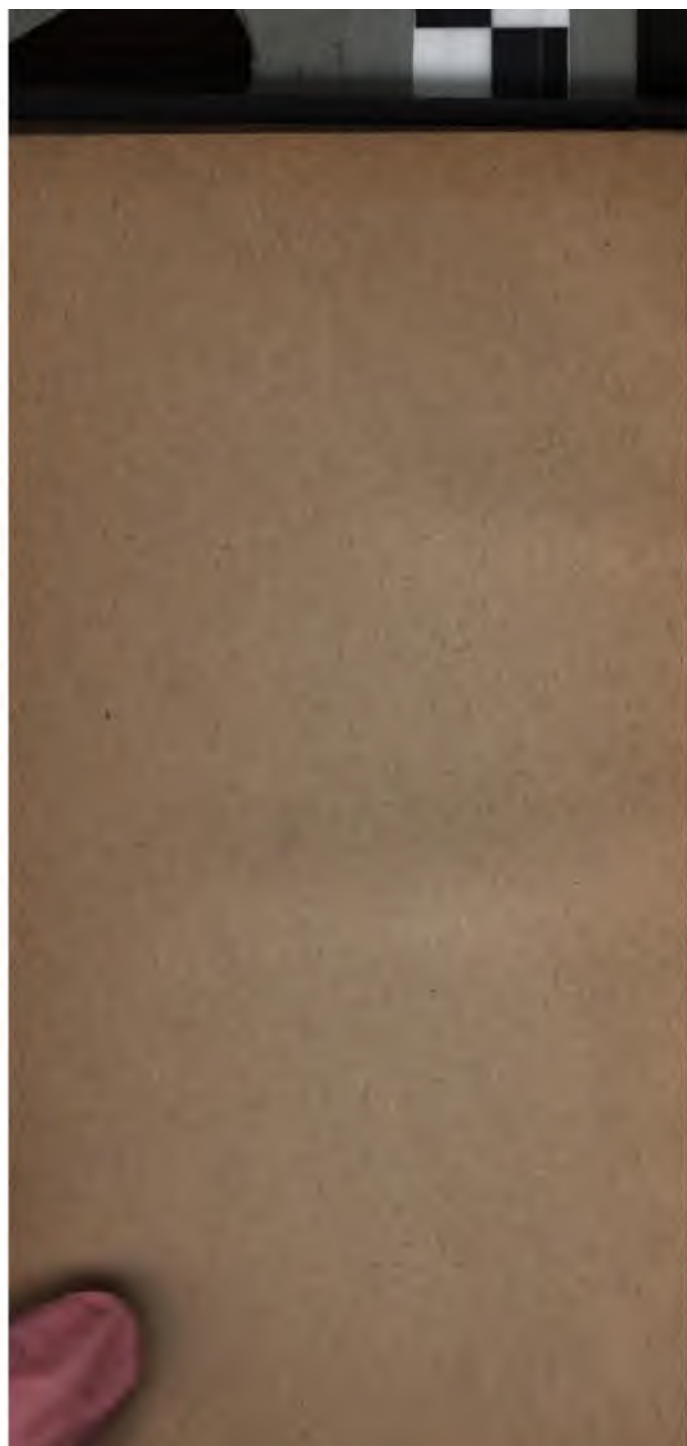
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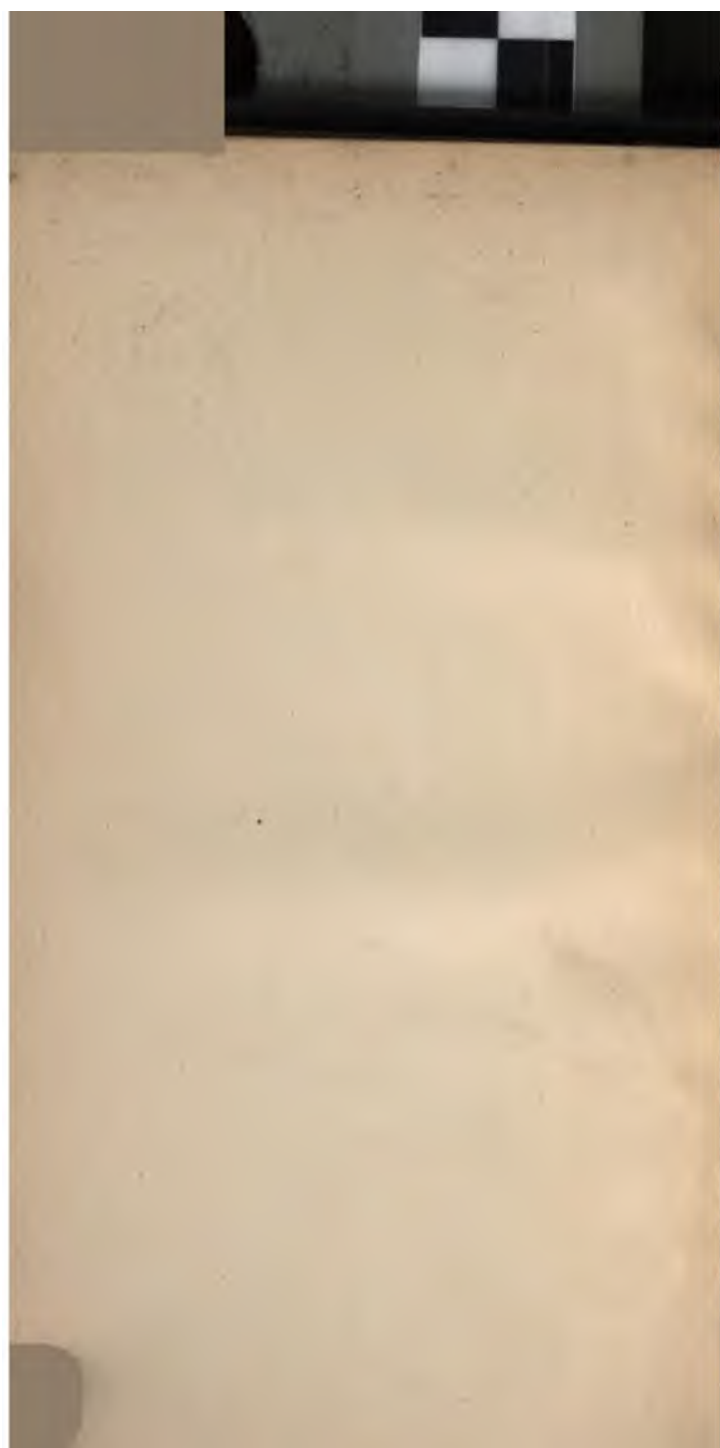




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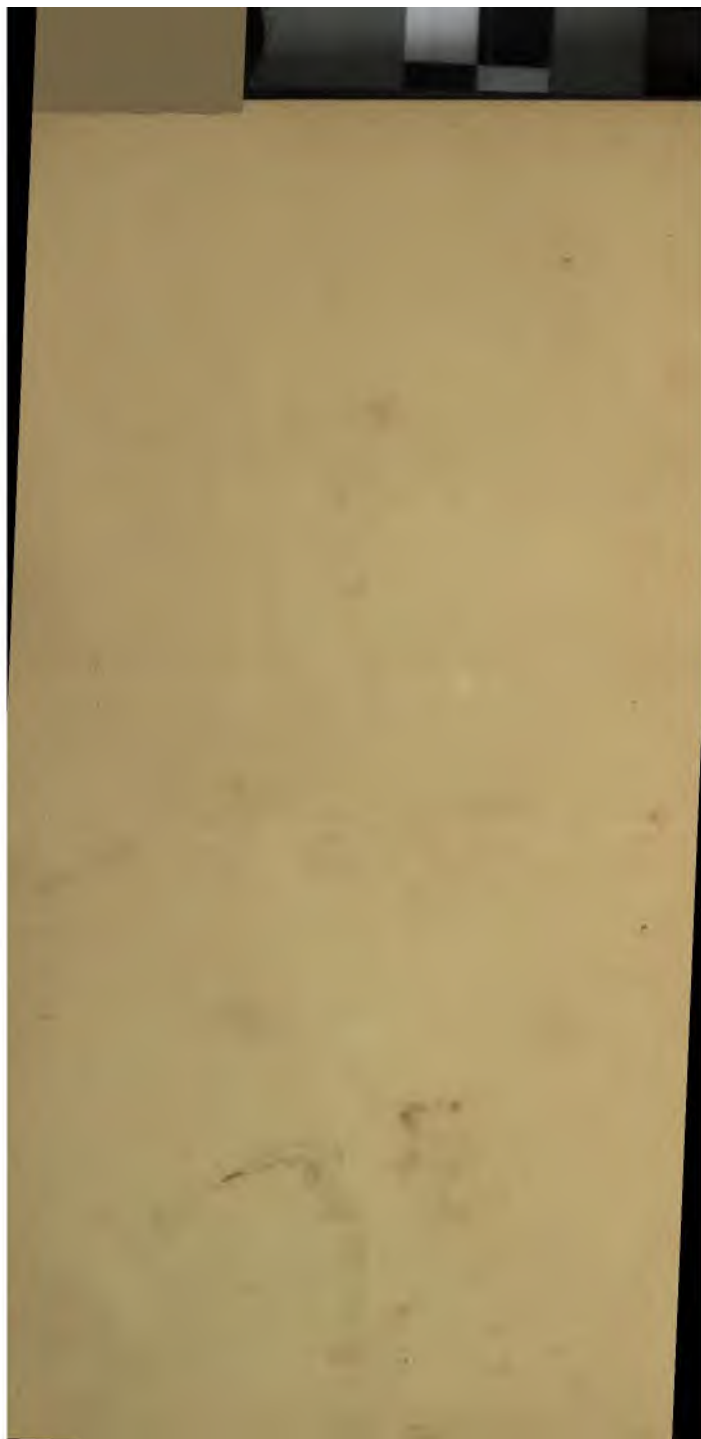


















A

NEW PHILOSOPHY OF MATTER;

SHOWING THE

IDENTITY OF THE IMPONDERABLES,

AND

THE INFLUENCE WHICH THESE AGENTS EXERT OVER MAT-
TER IN PRODUCING ALL CHEMICAL CHANGES
AND ALL MOTION.

BY GEORGE BREWSTER, A.M.,

PROFESSOR OF NATURAL SCIENCES IN DURLINGTON UNIVERSITY, IOWA.

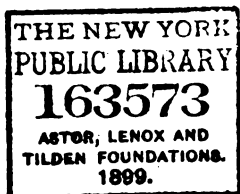
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PREFACE.

As long ago as 1837, I lectured upon the subject of this work in Annapolis, Baltimore, Philadelphia, New

York, Boston, and some other eastern cities, and in Norwalk, Milan, Akron, Middlebury, Canton, and other places in northern Ohio.

The theory was *novel*—was entirely my own, unaided by books,—the result of *investigation*, instead of *imitation*. Being novel, it was sneered at and opposed by some of the scientific, as novelties almost always are, when first promulgated.

In 1843 I published the first edition in an obscure western village, under very disadvantageous and embarrassing circumstances. So poor was the mechanical execution of the work, and so many typographical mis-

takes did it contain, that I was so ashamed of its appearance that I never introduced it into the eastern market, but sold the whole first edition of two thousand copies in the back woods of the western country.

When the work was first published in 1843, wishing to have it reviewed by some scientific judge, I put it into the hands of a friend of mine—a *learned professor* in one of the western colleges—requesting him to give it a thorough dissection, and then report. He did so, and reported *favorably*, although he remarked to another friend that he did not dare to publish *all* he felt inclined to do in its commendation, for fear of bringing his own scholarship into disrepute, as the world was not ready for its reception, but uttered the prophecy that “it would be the *prevailing* theory within fifty years.”

Although published and sold in the West, yet a few copies found their way to the East. In 1848 I was written to by a professor in an *eastern* college, stating that he had “got a glance at my ‘New Philosophy of

Matter ' in the hands of another, and had offered *three prices* for it, but could not get it at *any price*," requesting me at the same time to favor him with a copy, if I could.

Thus has that theory, which was at first sneered at, simply for the want of examination, been, for the last twenty years, silently but *surely* gaining converts among the scientific, so reliable is the adage, that

" truth is mighty, and will prevail."

As almost always happens, however, when prejudice begins to be overcome, and opinions begin to be entertained favorably by the intelligent popular mind, *strip-lings* who had but just entered "*their teens*," when I first promulgated these ideas, are now starting up with all the pomposity of shallow-brained plagiarists, and claiming, forsooth, the honor or dishonor, as the case may be, of ORIGINATING those ideas.

Induced by these efforts, and considerations like these, aided by the coöperation of intelligent and able publishers, I have re-issued the work in its present im-

proved form with the intention of introducing it to the notice of the whole country, east as well as west.

Very conscious am I that the work has faults; for I by no means claim for it or myself infallibility. Those faults I commend to the charitable lenience of the reader. At the same time, it is believed to contain enough important truths to warrant its republication.

GEORGE BREWSTER.

St. Louis, Missouri, *August*, 1858.

CONTENTS.

CHAPTER I.

Principles by Which an Author in the Production of a Work Should be Guided; and by Which Novelty is Justified	13
--	----

CHAPTER II.

Discussions of a General Proposition, in Which it is Assumed that there are Three Essential Principles in Nature	23
---	----

CHAPTER III.

A Brief Outline of the Subjects Investigated in the Work	34
--	----

CHAPTER IV.

History of the Discovery of Electricity and the Progress of Elec- trical Science	39
---	----

CHAPTER V.

Critical Examination of the Theories of One and Two Electric fluids	56
--	----

CHAPTER VI.

Theory of Two Electric Fluids proved Erroneous by a Variety of Facts	
---	--

CHAPTER VII.

The Theory of One Electric Fluid Proven to Harmonize with Facts . 75

CHAPTER VIII.

A Description of various Interesting Experiments, by Which it
is Proven that Electricity and the Lightning of the Clouds
are Identical 86

CHAPTER IX.

History of the Discovery of Galvanism, and Description of Appa-
ratus and Experiments 95

CHAPTER X.

Description of Apparatus continued, and of Chemical Analyses
by its Use, by which it is Proven that Electricity is the Cause
of Chemical Changes 109

CHAPTER XI.

Experiments and Analyses by Galvanism continued 121

CHAPTER XII.

Galvanic and other Experiments by Sir Humphrey Davy, M. Pouil-
let and Others, and Their opinions derived from Them . . 127

CHAPTER XIII.

Quotations on the Subjects of the previous Chapter from Profes-
sor Thompson, of Glasgow 142

CHAPTER XIV.

Application to the Support of our Theory of the Facts already
Ascertained 151

CONTENTS.

ix

CHAPTER XV.

Analysis of the Quotations of former Chapter—Wherein the Conclusions of Scholars were True and wherein False—Won- drous Phenomena of Petrefaction	155
---	-----

CHAPTER XVI.

Oxygen critically Examined by a Variety of Tests, and Proven to be a <i>Positive</i> instead of a <i>Negative</i> substance, as Assumed by Sir Humphrey Davy and Others	173
---	-----

CHAPTER XVII.

Hydrogen in Accordance with Pouillet's Experiments, and Con- trary to the Opinions of Thompson and Davy, proven to be <i>negative</i>	186
---	-----

CHAPTER XVIII.

Animal Electricity and Electric Pathology examined, and the Phenomena of Life, the Causes of Diseases, and Proper Rem- edial Agents considered	200
--	-----

CHAPTER XIX.

The Investigation of the Interesting Subjects of the Former Chapter continued	211
--	-----

CHAPTER XX.

History of the Rise and Progress of Electro-Magnetism	225
---	-----

CHAPTER XXI.

Application of the Power of Electro-Magnetism to the Produc- tion of Rotary Motion	234
---	-----

CHAPTER XXII.

Minute Examination of the Interesting Subject of Solar Light, in which There is an Accumulation of Proof that it is Elec- tric	244
--	-----

CHAPTER XXIII.

Investigation of Solar Light and the Accumulation of Proof that it is Electric, continued	254
--	-----

CHAPTER XXIV.

The Inference from Experiments and from Facts, that Light and Electricity are Identical, is Perfectly Logical	263
--	-----

CHAPTER XXV.

Accumulation of Proof that Caloric is Electricity	269
---	-----

CHAPTER XXVI.

Light and Heat identical, and Electric	274
--	-----

CHAPTER XXVII.

The Lightning of the Storm-Cloud proved to be the Caloric of Vapor liberated	279
---	-----

CHAPTER XXVIII.

The Directive Power of the Needle of the Compass, and the Northern and Southern Lights, proved to be Electric	289
--	-----

CHAPTER XXIX.

Gravitation proved by Conclusive Fact and Argument, to be the Electro-Magnetism of Bodies	297
--	-----

CONTENTS.

xi

CHAPTER XXX.

Attraction of Cohesion, and Capillary Attraction produced by Electricity	306
--	-----

CHAPTER XXXI.

The Motions of the Earth—Both Diurnal and Annual—Governed by the Electricity of Sunlight, according to Definite and Tested Laws	314
---	-----

CHAPTER XXXII.

The Motions of other Planets, of the Moons and of the Comets, Governed by the same Agent	322
--	-----

CHAPTER XXXIII.

Animal Magnetism and the Immateriality of Mind considered, and the Latter proven to be Essentially different from the Former	333
--	-----

CHAPTER XXXIV.

Mind not Electricity, but the Controller of Electricity. Spiritualism and the Agency of Disembodied Spirits, considered .	341
---	-----

CHAPTER XXXV.

The Authenticity and Literality of Genesis, defended from the Assaults of Skepticism	352
--	-----

CHAPTER XXXVI.

The wondrous Phenomena of Creation, as Described by Moses, proven to Correspond precisely with the Facts of Science .	
---	--

CHAPTER XXXVII.

Solution of the uestion as to What becomes of the Materials of Suns and Worlds that have erished by Conflagration . . .	373
--	-----

CHAPTER XXXVIII.

The Irresolvable Nebulæ constituted the "Light" of the Third Verse of Genesis, and was, by the Creations of the First Day, Separated into Worlds and Free Caloric	381
---	-----

CHAPTER XXXIX.

The Phenomena of the Primary Fossiliferous Strata Explained, and Geology Reconciled with Genesis	390
---	-----

CHAPTER XL.

The Creations of the Second, Third, Fourth, and Fifth Days, re- conciled with Geology, and the Production and Installation of Man, as Lord of the Whole, considered the Crowning Work	394
--	-----

CHAPTER XLI.

A Universal Deluge Proven by History, Geology and Reason, in Opposition to the Opinions of Sceptics and the Revelations of Lying Spirits	403
--	-----

A NEW PHILOSOPHY OF MATTER.

CHAPTER I.

A NEW PHILOSOPHY OF MATTER.

"A New Philosophy of Matter!" echoes, perhaps, some cavilling reader, in a tone of scornful exclamation, after looking at the assuming title of this work. "What, pray tell, is that? Ah, it must be some wild phantasm of some opinionated, egotistical and reckless innovator upon established and time-honored usages!"

But not too fast nor too harsh, respected reader, in the expression of hastily formed opinions. Permit us a few words of defence here. Give us *first* a patient and candid hearing, and *then* judge.

Were not this work, as it purports to be, "A New Philosophy of Matter," we certainly should not, with our impressions of what is appropriate in authorship, have committed the glaring folly of its publication, nor would any one be now reading it with a cavilling spirit.

It is new, was *intended* to be new, *emphatically* :

in all its main theoretical positions, although many of the facts chosen to sustain and defend those positions have long been known by the scientific, and all of them are as old as creation; and as matter, ponderable and imponderable, is the subject chiefly discussed, it is, therefore, called "A New Philosophy of *Matter*."

But before proceeding directly to the discussion of the subject, we shall endeavor to disarm unreasonable prejudice, by presenting a few considerations in justification of the course we pursue. It has long been our impression, and is so still, that no author should appear before the public in the publication of any work unless he can produce,

- 1st. SOMETHING NEW.
- 2d. SOMETHING IMPORTANT.
- 3d. SOMETHING TRUE.
- 4th. SOMETHING INTELLIGIBLE.

The reasonableness and propriety of each of these propositions will be apparent upon a moment's consideration.

PROPRIETY OF SOMETHING NEW.

It should be one prominent aim of an author to produce *something new*, either by the discovery of latent facts, or the correction of untruths and false theories in science, or the systematic classification of facts long known, but long scattered in chaotic and useless confusion. For to lecture or to write upon any subject,

without advancing new thoughts, or suggesting something which has not already been suggested by authors or by lecturers, seems to be "treading in the footsteps of our illustrious predecessors," to no very material advantage to the world. This, I am aware, is often done. A very considerable number of books, which, year after year, emanate from the press, and no small share of the lectures delivered upon the sciences, are nothing more nor less than the repetition of old ideas in a new garb, to prevent the petty plagiarism from being too barefaced, and that garb too oftentimes made less elegant and less attractive than the original. Something higher than this should be the aim of an author. No bold, independent and vigorous thinker—none but a mere intellectual parrot—would stoop to such servile imitation of others, when before him lies, spread out in endless perspective, a vast, unexplored, immeasurable wilderness of knowledge, which would give scope for ages upon ages, yea for eternity itself, to the untamed energies of the most powerful intellect that men or angels ever saw.

But it must be acknowledged that the fortune of him who has thus forsaken the beaten path of generations, and has aimed at *originality*, has not often been an enviable one. Such an one has frequently ascertained, by bitter experience, how hard it was to "climb the steep where fame's proud temple shines afar." He has often found that the untrodden course, which he has marked out for himself, has been any thin

but a flowery path—briars and thorns have grown thickly there. In it he has encountered the chilling blasts of poverty; the discouraging dissuasions of friends; oftentimes a concentrated and malicious chorus of serpent hisses from enemies, and has been pointed at with the finger of scorn as a poor, crazy enthusiast, or a visionary builder of air castles.

This conclusion will be irresistibly forced upon the mind of any one who carefully consults the records of the past. When the celebrated William Wirt remarked, with regard to the perils of innovation, "*Woe betide the hand that plucks the wizard beard of hoary error,*" he was doubtless looking at the history of by-gone time. Men used to regard the slightest encroachment upon established laws in *politics, religion and science*, how glaringly erroneous soever those laws might have been, as reckless and wicked fool-hardiness. Facts in abundance prove this. A Columbus, a Newton, and a Fulton might promulgate new theories of the utmost importance, and sustain and defend them with argument piled upon argument, mountain high—with argument upon argument, too, the most rational, conclusive and convincing, and yet they would invariably fail for a long time to convince. Prejudice, like an ancient mail coat of steel, enclosed the mind, and warded off the shafts of conviction. Many men, and even men reputed to be scientific, would obstinately persist in scepticism until actually *forced* to believe, by the *common sense*

and the *common* opinion of the world around them—until the truth of rejected theories would blaze upon that scepticism with such overpowering intensity as to consume it, and make those who harbored it either ashamed of their extreme dullness of apprehension, or else of their dogged obstinacy.

ERA OF LIBERALITY.

The present age, compared with those to which allusion has been made, is peculiarly and emphatically distinguished for its liberality. An important prophecy is in the very process of fulfillment. Many are "running to and fro," and knowledge is more rapidly increasing than at any former period of the world. Acceleration marks the progress of everything. Instead of travelling, as formerly, at the snail-like pace of three or five miles per hour, we now dart away upon the wings of steam, at a rate varying from *fifteen* to *sixty* miles per hour; and the progress of man in science keeps tolerably even pace with this progress in locomotion. This is quite as much owing to the fact that "many run to and fro," as to any other fact whatever. Individual acquisition in science is not so much hoarded as formerly; it is rather appropriated as common stock—rather scattered *broad cast* over the land.

The days of such prejudice and scepticism as we have before described are evidently passing rapidly away, in consequence of this increasing knowledge.

It is true that men are cautious how they give a ready credence to novelties in theory or in practice, but, as a general thing, perhaps not too cautious. A certain watchfulness is doubtless necessary for the safeguard of the bulwarks of truth from sacrilegious and ruthless innovation. But further than this incredulity at the present day scarcely goes. So rapid, so surprising and so successful have been, and are still, the improvements and discoveries of the age, that puzzled scepticism stands confounded and amazed, not knowing what to *say*, or scarcely what to *think*. A very great change has come over the opinions and feelings of the world. Theories in science may now be promulgated which discredit all preconceived sentiments upon the subject at issue, and explode them, and still they will receive a candid and respectful hearing from an intelligent community, and if they happen to be supported by even the *plausibility* of argument, that thinking community will not reject, even if it do not embrace them—there will only be a suspension of judgment for *more light*. *This is wisdom*. By such a course of policy, truth in science, or upon any subject whatever, is sure to triumph, and error to be overthrown and discredited, however subtly interwoven with the maxims and policies of society, and however supported by the authority of great names.

PROPRIETY OF SOMETHING IMPORTANT.

It should be another prominent object of an author to suggest *something important*. For, it should ever be kept in recollection, that "all is not gold that shines," and that, although "variety is the spice of life," yet, that what is *new* is not always *important* or *valuable*. Ideas may have originality, and yet, at the same time, they may be either as simple as the babbling and nonsense of mere idiom, or as unreal as the wildest and most incoherent ravings of stark madness; the likeness of nothing in the heaven above, or in the earth beneath, or in any locality within the whole wide regions of sober thought. Matter then, worthy of the attention of intelligent society must not only be *novel* but *important*.

PROPRIETY OF SOMETHING TRUE.

Another prominent object of an author should be to promulgate *something true*. For ideas may be both *novel* and *important*, and yet, if they are incorrect—if they lack the very essential support of incontrovertible fact, they are unworthy of credence. Without this, a theory may be both beautiful and grand, but must be as evanescent as it is beautiful, and as unsubstantial as it is grand.

The example of Sir Isaac Newton is worthy of the attention and imitation of scholars and authors. His discriminating intellect promptly and invariably rejected every theory and every proposition, howeve

plausible, which had not the firm and imperishable basis of fact and conclusive demonstration. He jumped at no conclusion, but came to it step by step, through the path of clear, patient, and logical deduction. Away from his presence, he sternly rebuked everything like surmise and conjecture, and gave no audience for a moment to any thing which bore not the characteristic features of scientific truth. In this respect, imitation of him would not be reprehensible: it would rather be a mark of wisdom.

PROPRIETY OF SOMETHING INTELLIGIBLE.

To cap the climax, an author should aim to promulgate *something intelligible*. This is quite as indispensable as any thing else. For thoughts may be *novel* and *important*, and have enstamped upon them the characteristics of immutable truth, and yet, if they be not expressed so as to be *intelligible*, they might just as well not be expressed at all. The professed object of all language, either oral or written, is to convey ideas to the minds of those to whom it is addressed. But language which is not understood accomplishes not the object for which it was invented, or, if it be understood by only *one* tenth, then *nine* tenths are excluded from its benefits, just as much as if they were required to decipher the meaning of the obsolete Egyptian hieroglyphics.

Now, if an author have ideas to communicate, which seem to be sufficiently *novel*, *important*, and *true*, to

warrant their promulgation, what should he do? Should he adapt his remarks exclusively to the taste and the comprehension of the few, who can emphatically be called the *literati*? Should he discourse learnedly in that technical phraseology, which, either from an imagined consequence, or else from the impulses of pedantic vanity, has been invented for the sciences, and which is never understood by the mass of readers as if those sciences were clothed in the dialect of one of the dead languages? Should he be ambitious to throw an air of mysterious profundity and scientific dignity around his remarks, or should he be mainly solicitous to be understood by all, and to adapt his language to the capacities of all of moderate attainments, either by avoiding altogether the use of blind and fresh-coined technical terms, or else, by fully explaining those which the imperious dictate of custom has made necessary and indispensable? There can be but one opinion upon this subject. The universal sentiment would doubtless be in favor of plainness. Aim to be understood instead of displaying ostentation would be the dictate of common sense. This can be done without sacrificing a proper dignity of expression, or condescending either to a vulgar coarseness and rudeness of language, or a low and childish puerility of remark. It can be done, too, without offending the taste even of the most fastidious among the scientific, or forfeiting the approbation of those who combine a commendable public spirit with exter

acquirements, and who wish to see knowledge widely disseminated among the mass.

OUR GUIDES.

Those four prominent objects, which have been thus considered separately, and which should be the guides of every author, will be the landmarks by which we purpose to be guided in our proposed work upon the ponderable and imponderable agents. It is our purpose that they shall contain *novelty, importance, truth,* and be made, if possible, *intelligible.*

CHAPTER II.

DISCUSSION.

HAVING indulged in these preliminary remarks for the purpose of dissuading prejudice, we shall now proceed to the discussion of our subjects.

Floating through books and periodicals, various indefinite surmises or conjectures, respecting the subjects which we purpose to discuss, are to be found scattered here and there, but all confused. Nothing is systematized or affirmed with positive confidence and certainty, or supported with a proper array of facts and arguments, except in a single instance, in that almost unknown, but yet invaluable scientific jewel—Dr. Metcalf's "New Theory of Terrestrial Magnetism," published in 1833, in which he assumes and *proves*, by logical demonstrations, which cannot be successfully controverted, that *Caloric* is *Electricity*.

THE ONENESS OF THE IMPONDERABLES.

After having written and lectured upon this subject in Baltimore and other places in 1838, we were favored by a friend with a perusal of this work, and were exceedingly surprised to find a perfect coincidence between our views, so far as *Caloric* is concerned.

subsequent investigations, we have come to the conclusion that, not only *Caloric*, but that all the other imponderables are one and the same agent—that Electricity, Galvanism, Magnetism, Light, Caloric, Gravitational, the Attraction of Cohesion, Capillary Attraction, and Chemical Attraction, are only different modifications of the same essential principle.

If this be true, as we hope by facts and arguments to prove, then there is an entirely new and unexplored field opened before the student in Chemistry and Natural Philosophy. By it, many things will be exploded as false, which have heretofore been taught in the schools as scientific truths, and many things will be systematized and simplified, which have been complicated, confused, and unintelligible. It seems to lead directly to the adoption of this one broad and comprehensive proposition, the basis or substratum of all knowledge.

A GENERAL PROPOSITION.

There are, of the productions of creative power, three distinct essences, or essential principles in the universe, and BUT three, and everything created and finite, of which we either have or can have any conception, whether it be animate or inanimate—physical, animal, or intellectual, can be referred to one or the other of these three essential principles, as to its native, legitimate, proper basis, or substratum.

This proposition, it will be seen, embraces within its comprehensive scope the whole illimitable domain of

science, both visible and invisible. Sceptics in the republic of letters, or old-fashioned bookworms, who regard the slightest encroachment upon what they may have read as sacrilege, will doubtless call this proposition sweeping and chimerical. But sweeping and chimerical as it may, however, seem to them or to others, it is believed, nevertheless, to be capable of satisfactory and even perfectly conclusive and logical demonstration, as may be shown hereafter.

There is a mysterious Trinity in Unity in the Being who created all things. There is a Trinity in Unity in man, who, in Bible language, is composed of "body, soul, and spirit;" and there is a sublime Trinity in Unity in nature.

The names of those three fundamental principles of our proposition we will here give in their natural order, together with a definition of their properties as concise and intelligent as possible.

PONDERABLE MATTER.

The first elemental principle of our proposition we shall call *Ponderable Matter*, it being the same technical epithet which is used in standard works. By this term we include all those substances of every name and form which are tangible—which can be noticed or appreciated by most of the senses by which we acquire ideas of external objects—which are measurable, and which have magnitude and weight.

ITS PROPERTIES.

The properties or qualities of this first essential principle of the created universe, we consider to be perfect inertness and inherent dormancy, meaning by those terms, that a substance under their influence has no activity or disposition to activity *in itself*; that it has therefore no power of changing itself, or of communicating motion to itself, either in its component parts, or in the aggregate or whole; that it would, therefore, remain forever changeless, as when left at creation, and forever unvaried by modification, a cold, motionless mass of inertia or sluggishness, unless operated upon by foreign agencies, sufficiently powerful to overcome that inherent disposition to remain forever sluggish and unmoved.

IMPONDERABLE MATTER.

The second essential principle embraced in our proposition, we shall call *Imponderable Matter* it being, also, the same technical epithet by which it is designated in the text books. By this term we include Electricity, Galvanism, Magnetism, Light, Heat or Caloric, Gravitation, the Attraction of Cohesion, Capillary Attraction and Chemical Attraction. These are all, in their nature, alike intangible. That is they cannot be handled so as to be examined like ponderable substances of the first class. They are inappreciable by most of the senses, immeasurable and have no perceptible magnitude or weight.

This *imponderable principle* is entirely distinct and different from ponderable matter, not derivable from it, but perfectly independent of it, and yet having such a natural affinity for it, by the inscrutable attraction of opposites, which seems to be an immutable law of nature, as to pervade it completely. Not a single particle of ponderable matter is there in creation—not an atom borne on the atmosphere—not a single mote floating in the sunbeam, but what is attended by its appropriate share of the imponderable principle, when all the elements are in equilibrium.

This wonderful and mysterious agent is extremely subtle—so subtle that it is invisible and imperceptible, except when condensed into the electric spark, or accumulated by the galvanic battery, or poured down upon us in the light of day, or gathered into focal intensity by the lens or burning glass, or exploded in the thunderbolt of the clouds, or collected together into that capacious reservoir of electric fire—the *Sun*. Elasticity unbounded is one of its characteristics and its activity is inherent, it being always in motion, for, if the balance of the elements be disturbed at all, and there be, anywhere in creation, a partial vacuum, or an abstraction of the subtle fluid, so far as to make that spot *minus* with regard to surrounding regions, it rushes in with irresistible velocity, and restores that disturbed balance. Rapidity inconceivable characterizes its movements. If impeded in the slightest degree in its everlasting career, and accumulated and

strained by appropriate exciting causes, it exhibits a fearful energy—an energy perfectly overwhelming, and bursts its bands with infinitely greater ease than did the unshorn Sampson.

REPRESENTATIVE OF DEITY.

It is that agent, independent of ponderable matter, at which we have already hinted, which pervades it omnipresently, according to certain definite laws, which will hereafter be explained, having a natural affinity for it, and possessing inherent power sufficient to overcome its inertia or sluggishness, to work all the chemical changes and produce all the motions in it, whether on the scale of atoms or of worlds or of constellations of worlds. It, in fact, seems to be the very representative of Deity himself, expressly appointed and commissioned to produce the multiform and almost countless transformations of matter—all the chemical changes of decomposition and recomposition, which are constantly progressing around us and throughout nature, and, by its inherent energy, and the activity which it imparts, to keep up the motions of the universe of material systems, and to invigorate both the animal and vegetable life, in its myriad forms, with which those systems are furnished.

MATERIALISM NOT SUSTAINED BY IT.

Some materialist may here draw the confident conclusion from what we have asserted, that imponderable matter is *mind*, and, that it is the *only Deity* in

the universe. Some have actually assumed this proposition. No such conclusion, however, results necessarily from the premises. Instead of favoring the doctrine of materialism in the slightest degree, I pledge myself to be prepared to show in its proper place in this work, that, from *this source*, alone, can be drawn the most powerful and convincing arguments which can possibly be drawn from nature to overthrow that doctrine. I am not one of those, who tremble to acknowledge an undeniable fact, lest that fact should seem, forsooth, to militate against my creed. The God of nature never would have created an agent, or have established a law, which, when *discovered*, and fully *understood*, would militate against his divinity, or undeify himself in the estimation of a *sound philosopher*. We must never deny the evidence of our senses, and discredit incontrovertible facts, lest, peradventure our *belief* should be overthrown by them, but should endeavor, by ingenuous and candid investigation, to ascertain *how they can be reconciled with our belief*.

MIND.

We now come, naturally, to the *third* essential principle of the created universe, which we denominate *mind*. Pure etheriality seems to be its constituent property, which term, we think, will correctly define its nature, if, in the acknowledged vagueness, looseness and imperfection of language, all shall attach to it an appropriate signification. The intellect is no more a

substance or the emanations of a substance, than thought or a train of thought is substance. As the emanations and exhalations, or the minute particles flying off from matter are matter *also*, so mind is, and, of necessity, *must* be, in the inherent fitness of things, of the same nature of its exhalations, which we know are *thought, intelligence, moral feeling, and volition*, properties which may be truly said to be *something* or *realities*, though there be no *materiality* about them.

Who, for instance, would affirm that an *idea* is matter? Has it length, breadth and thickness, either perceptible or imperceptible, as have all the particles of matter, either ponderable or imponderable, how minute soever they may be? To attempt seriously to disprove such a proposition would be too much like battling, with Quixotic valiancy, the unsubstantial shadows, which chase each other over the landscape. Such an attempt would sufficiently establish a man's claim to the diploma of a confirmed Bedlamite, and would entitle him, beyond all controversy, to a straight jacket, and an introduction to the benevolent hospitalities of a mad-house. Such a proposition is too preposterously absurd for a single moment's belief. The influence which the intellect, or its controlling power, the will, exerts over the other two fundamental principles of creation entirely precludes such a belief. For, as the imponderable principle controls the ponderable, so *mind* controls both the *one* and the *other*.

The intellect, or will of the carpenter, for instance, controls the muscles of his physical frame, through the action of the nervous fluid or animal electricity upon those muscles, and, by the strength and motions of his physical frame, so controlled, the edifice is constructed, and the grand, the beautiful, and the symmetrical in architecture are made to adorn the dome, the temple, and the various other fabrications of the mechanic arts.

The imponderable principle is, also, subject directly to the volition of intellect, although it has no guiding will of its own.

A Franklin, for instance, could extract the subtle fires from the storm-cloud, as it passed over head, with his electrical kite, and conduct the red and crashing bolt, harmless to the earth by his lightning-rod.

Galvani and his successors could extract the same fiery fluid from a certain association of zinc, copper, and the acids, in a stream strong enough to burn iron like tinder.

We will to move a finger, or an arm, or a foot, and it moves, because its controlling muscles are influenced by the animal electricity thrown upon them by the action of the willing power or mind.

So we have seen that there are *three* created principles in the universe, each entirely diverse from the others, the first being under the control of the second, and both the first and second under the control of the third, as will be conclusively demonstrated, in that

part of the following lectures in which *Animal Magnetism* will be investigated.

THE UNCREATED PRINCIPLE.

There is, in the universe, still another Principle—if it be right to call the same a principle—which I have not included in my classification, because it comes not within the list of created substances. Its attributes are Omniscience, Omnipresence, Omnipotence and Eternity, as they must, of necessity, be, in the very inherent nature and fitness of things, if uncreated or self-existent, for an uncreated agent could not possibly be otherwise than infinite.

This self-existent, eternal principle we call Deity. Beyond Him we hold that there can be nothing either created or uncreated, finite or infinite. He embraces and controls and pervades and governs everything. As electricity governs inert matter, and created mind governs both, in a certain sense, so this fourth mysterious, incomprehensible, all-pervading Essence gives immutable, irresistible laws to the whole three in an *unlimited* sense, and does precisely what he *wills* throughout the whole *illimitable* vastness of both *duration* and *space*.

In proof of the positions, which we have, in a measure, assumed thus far, without having defended them with illustration and argument, the following work will investigate minutely the properties, laws and peculiar agencies of the three essential principles of

creation, together with an occasional allusion to the uncreated Fourth, or the Supreme Architect. And we design, also, as definitely as possible, to show the relationship which exists between those three essential principles.

CHAPTER III.

SUBJECTS.

THE first subject of investigation will be *common electricity*. We shall show *how* it was discovered, what are the immutable laws by which it is ever governed, and what are the manifold and powerful agencies or influences which it exerts over matter, in the production of all chemical changes and all chemical analyses.

We shall then investigate, in their appropriate order, the other imponderables, viz : Galvanism, Magnetism, Light, Heat or Caloric, Gravitation, the Attraction of Cohesion, Capillary Attraction, Chemical Attraction and Animal Magnetism, and show that they are governed by precisely the same laws as common Electricity ; that they exert the self-same influences over inert matter, and that they are, therefore, the same individual agent, though known by a variety of names, and exhibited under a variety of modifications.

During the course of this investigation, we shall endeavor to show that the Sun is the grand reservoir of electricity—the great galvanic battery of the solar system—that its influence over the planets is *electric*—

that their motions, both diurnal and annual, are produced by that influence, in accordance with those electrical laws of attraction and repulsion which can be tested in the laboratory upon little pith balls—that the Attraction of Gravitation, as well as that of Cohesion, is caused by the light and Caloric of the Sun, in their operation upon the material of the earth, in constituting it a magnet—that terrestrial Magnetism and the north and south polarity of the earth, which attract and guide the needle of the mariner's compass, are produced by the same cause; that the reason why the needle points to the north and south, rather than to the east and west, is because electricity, it is now well known, influences and guides it, and because those streams of Caloric, or solar heat, which, in obedience to an immutable law of nature, run continually from the equatorial regions to the point of greatest cold in the polar regions, is *that same electricity*—that that point of maximum cold is proven, by the observations of navigators, in their voyages of exploration in the high latitudes of the Arctic and Antarctic seas, to be the magnetic pole of the earth both north and south, which varies from the geographic pole, in some seasons, fifteen degrees or more—that the Aurora Borealis and Aurora Australis, or Northern and Southern Lights, stream up from these points of greatest cold, or the magnetic poles of the earth, and are, therefore, the electricity or Caloric, that runs continually from the equator to those magnetic poles, and there passes

outward and upward, into the rarer regions of the atmosphere in its circuit, and forms precisely the same lambent, nebulous, waving appearance which electricity exhibits when passing through an exhausted glass tube, or any other exhausted medium.

We shall endeavor, also, to demonstrate, by conclusive proof, that it is the vivifying principle of both animal and vegetable life, and, as far as possible in a science as abstruse as this, to show *how* it operates—that it is the active efficient agent of both the decomposition and the recomposition of the organic structure of men and animals, which is continually going on—that its application in cases of disease, by those who understand thoroughly its laws and chemical agencies, is of invaluable consequence, whether it be by machinery or by animal magnetism, and that by its scientific and proper application, it can be made to cure Epilepsies, Apoplexies, Palsies, Rheumatism, Fever and Ague, and, indeed, almost every other disease that “flesh is heir to,” except old age, and both *how* and *why*, in most cases, it can be done—that it can be done by known and tested chemical agencies, in strict accordance with immutable chemical law.

In the progress of the discussion we will endeavor to show what influence mind has over this subtle agent, in producing the motions of the human body, and wherein that influence is different from the choice or instinct which controls the motions of brutes, by which we shall prove that Animal Magnetism, so far from

being a "*miserable humbug*," is a sublime science, which can be sustained by as many incontestible proofs as any science under heaven—proofs, too, which, if any man would seriously doubt, he must first doubt the evidence of his own senses, or his own personal identity.

We shall also show that Animal Magnetism, so far from having a tendency, as some suppose, to bring the truths of our holy religion into disrepute and discredit, lends a most efficient and powerful aid to sustain them, and rightly considered, must lead every candid mind to the conclusion that we are, in truth, "*fearfully and wonderfully made*."

Finally, as this discussion is about Matter, and as it will be quite appropriate in this connection, we shall examine the phenomena of the Creation and the Deluge scientifically, and, without investigating the theological merits of the question, shall show that Moses' account of the events is purely and strictly philosophical, and in literal accordance with the known facts of Geology.

In the discussion of those subjects, it will be perceived, by a perusal of the following pages, that we have, in many parts, adopted the argumentative style, based upon a few choice facts, selected from a mass that might have been collocated and inserted, and that, in some places, the thread of argumentation is drawn out somewhat attenuated.

This has been done *purposely*, from the fact that we

were aware that many, and indeed almost all of the most important positions taken were *novel*, and needed, of consequence, to be defended at every apparently assailable point, from the attacks of prejudice.



CHAPTER IV.

COMMON ELECTRICITY.

"COMMON ELECTRICITY," echoes the reader. What is that?" We will explain. We distinguish it by the epithet of "*common*," not because there is any *essential* difference between it and Galvanism, or its other modifications, but simply because the phenomena, which we shall investigate in the present connection, are those, which have been the longest and the most universally known, and, with the manifestations of which, all are more or less familiar.

This subject we intend to examine critically and very minutely, for, upon it is based an important science, and, in order to understand that science thoroughly, we must thoroughly investigate its elementary principles. By the unerring test of experiment, we shall, upon a small scale, within the immediate purview of the senses, determine the laws and the agencies by which it is ever governed. Having ascertained these, with satisfactory certainty, they will serve the valuable purpose of a chart, a compass, and a pilot, as it were, upon the broad and interminable ocean of investigation, far from the sight of land. Yes, with these valu-

able auxiliaries, we can enter the vast laboratory of nature, and show how, upon a large scale, the planets are wheeled upon their axis, and impelled in their mystic dance around the Sun, by the self same force that attracts and repels pith balls. For no one will dispute the fact, that the aggregate or whole is governed by the very same laws and agencies, by which the individual parts and particles of that whole are governed. This proposition will be found to be unerringly true, apply it *where* you may, and as *extensively* as you may. The law, by which an atom gravitates, or several atoms cohere or cling together, is the law precisely by which worlds gravitate and cohere. The laws, by which a drop of water is held in a globulous state, are the same precisely, which hold the ocean together. There is no deception in nature. She is no coquette. She speaks the language of uniformity and consistency throughout her wide dominions, and you will never find her conduct, at one time, or in one respect, at variance with her conduct in another. Having ascertained a fact or law in physics, beyond the possibility of mistake or the shadow of a doubt, other facts and other laws, bearing a relation to the same thing, will, when discovered, uniformly and universally sustain the first fact or law. This admirable certainty and uniformity in the operations of nature enables astronomers to foretell eclipses for years before their occurrence with confidence, and to the definiteness of a single moment—to predict the transits of Venus, and

give almost the precise data, even for the flight and return of the eccentric comet.

ORIGIN OF THE NAME.

Electricity was first detected or discovered in a substance called in English, amber, which substance in the original Greek was called *electron*, from which the term *electricity* is derived. This word *electron* is also derived from *electore*, another Greek word, which signifies, *the beaming Sun*, and, if it does not indicate that the ancients supposed the Sun to be the fountain of this subtle fluid, it at least develops a remarkable accidental coincidence.

ITS DISCOVERER.

Thales, a celebrated Grecian of the city of Miletus in Ionia, who lived 600 years before the Christian era, and who was the contemporary of Pythagoras, is reputed to be the discoverer of this remarkable property of amber. He ascertained, probably by accident, that when rubbed, it acquired the power of attracting to itself certain light bodies in its immediate vicinity. For the want of amber, the student can illustrate the phenomenon with a stick of sealing wax.

Familiarity with facts should never be suffered to lessen their interest, nor should we overlook the *simplest* truths; for, a thorough knowledge of those simplest truths, often leads to the discovery of the grandest and most sublime, while he that despises the "day of small

things," will, probably never live to see the day of large things. The most magnificent results often thus originate. The dim dawning of the morning precedes the blaze of the meridian. The diminutive acorn springs up and becomes an oak, monarch of the forest. The majestic Amazon first issues as a little rill on the eastern declivity of the Andes. A neglected spark kindles a conflagration, and millions of wealth are lost in ashes. So with a thousand other facts. Their origin is simple, but their results are grand.

WONDROUS PHENOMENA.

As the sealing wax, before being rubbed, is passed over little bits of paper prepared for the purpose, they are perfectly quiescent. Both are in a state of natural equilibrium or balance. Having excited it, however, by friction, it immediately exhibits a singular power unknown to it before. In this little experiment, trifling and simple as it may appear, there are treasured up volumes of wonder and inscrutable mystery, enough to puzzle for ages the clear-sighted penetration of a Newton himself. What is it that first diffuses over those bits of paper a tremulous quiver? then sets them upright as if alive, and then makes them leap up, as if either in affection or in anger, to the cause of their momentary animation. Echo only answers, "What is it?" The chemist is puzzled and silent, the books answer not, and no one can tell. The influence of the charmed sealing wax over those bits of paper is

beyond the comprehension of the most gigantic intellect. All that can be known is that it is *Electricity*, and that its operations are guided by certain fixed and immutable laws.

ASTONISHMENT JUSTIFIED.

No wonder Thales stood in astonishment when he made the discovery. No wonder he thought the amber animated with a principle of vitality. The emotions of the mind, when a grand fundamental or elementary truth first breaks upon it, are unutterable, and cannot be apprehended by the dull phlegmatic, who always plods along in the beaten path of his grandfathers. Such emotions often find vent in exclamations, similar to those of Archimedes in Greek, when he had discovered the solution of a difficult problem, upon which he had been long and intensely studying. In ecstacy he exclaimed—"eureka, eureka,"—"I have found it, I have found it."

CELEBRITY OF THALES.

Before proceeding, it may be proper to remark that Thales was no ordinary man. "Like most of the ancient Grecian sages, he traveled into Egypt, lived in that country several years, contracted friendships with the priests, then the depositories of science, became deeply skilled in all their mysteries and learning, and, returning to his own country deeply stored with the knowledge of the East, he ranked as the first of

the seven wise men of Greece, and became the founder of the Ionic school." Apuleius, an eloquent writer of the second century, thus speaks of him :

"Thales, the Milesian, was decidedly the most eminent of the seven famous sages, for he was the first inventor of geometry among the Greeks, the most judicious inquirer into the causes or nature of things, the most skillful observer of the stars. He made great discoveries by small geometrical lines, in the regulation of times and seasons, the theory of the winds, the course of the stars, the *wonderful causes of thunder*, the oblique motions of the planets, the revolution of the sun, and the reason of the increase, decrease and eclipse of the moon."

DISCOVERIES OF THEOPHRASTUS.

From the time of Thales to that of Theophrastus, a disciple of Aristotle, who lived between two and three centuries after him, no new discoveries were made in electricity, which is somewhat surprising, since it is no local or occasional agent, but coeval with time, pervading all substances omnipresently, and being the palpable cause of some of the grandest scenes in nature.

In a work of Theophrastus, entitled in Greek, "*Peri Lithone*," he ascribes the same property which Thales discovered in *electron* to the lapis lynceus, the substance now called Tourmaline. "It possesses," says he, "an attractive power, like amber, and, as they say,

attracts not only straws and leaves, but copper also, and iron, if in small particles."

From the period of Theophrastus, no allusion is made by authors, for more than two thousand years, to any but the discoveries already noticed, and, therefore more than twenty-three centuries elapsed from the observations of Thales, before any material addition was made to the stock of electrical knowledge. Since that, for the last two centuries, its accumulations have been vastly more rapid and increasingly important.

SIXTEENTH CENTURY.

In 1600, William Gilbert, physician to King James I., in a Latin work, entitled "*De Magnete, magnetesque corporibus*," gives a description, towards its close, of a great variety of electrical experiments, entirely new.

A fresh impulse appears to have been given, during this century, to the study of electricity, by the discovery of the phenomena of magnetism, as it seemed in some respects to possess properties similar to the loadstone.

By his experiments, Dr. Gilbert added largely to the meagre list of electrical substances. He ascertained that Diamonds, Sapphires, Carbuncles, Iris, Opals, Amethysts, Beryl, Crystal, Bristol Stones, Sulphur, Mastic, Hard Wax, Hard Rosin, Arsenic, Sal-Gemm, Rock Alum, common Glass, and Stibium, or Glass of Anti-

mony, have the power, when excited, to attract light bodies; and that this influence is not only exerted over leaves and straw, but, indeed, over all matter, which is not extremely rare. He also ascertained that friction was necessary to produce electrical phenomena, that it was most potential when light and quick, and that electrics could be most strongly and permanently excited, when the air was dry and the wind north or east.

WANT OF APPARATUS.

For the want of suitable apparatus, this philosopher encountered many obstacles, as did all the rest of the early investigators of the science. His experiments were principally made with long, thin pieces of metal, and other substances freely suspended on their centres, to the extremities of which he presented the electrics he had excited.

WILD THEORIES OF DIGBY.

Thirty years after the publication of "*De magnete, magnetesque corporibus*," the celebrated Sir Kenelm Digby, in his "Treatise concerning the nature of bodies," expresses the following singular notions respecting the influence of electricity.

"Attraction," says he, "is made by an attenuated emanation or a continuous effluvium, which, after some distance, retracteth into itself, as is observable in drops of syrups, oils, &c., which, spun at length,

retire to their dimensions. Now these effluvia advancing from the body of the electric, in their turn, do carry back the bodies, whereon they have laid hold, within the sphere or circle of their continuities; and these they do not only attract, but with their viscous arms, hold fast a good while after, and, if any shall wonder why these effluvia issuing forth, impel and protrude not the straw before they can bring it back, it is because the effluvia, passing out in a smaller thread and more lengthened filament, stirreth not the bodies imposed, but returning into its original, falls into closer substance and carrieth them back into it.

Such fanciful hypotheses may be amusing, and exhibit an inventive ideality, but should never be indulged by a philosopher in the form of positive assertions, unattended by positive proof, as in the quotation just made. They advance not true knowledge but rather becloud and bedim it.

DR. BOYLE'S INVESTIGATIONS.

The learned Mr. Boyle, by his investigations towards the close of the seventeenth century, enlarged the catalogue of electrics somewhat, and ascertained by his experiments, that the electrical properties of bodies are increased by wiping and warming them before they are rubbed. Bodies of all kinds he imposed were attracted indiscriminately, and that

attraction took place in a vacuum as well as in the open air.

To this time philosophers had supposed that electricity possessed only an attractive power. For Dr. Gilbert, in his "*De magnete, magnetesque corporibus*," remarked that magnetism possesses both an attractive and a repulsive power, but that electricity possesses the latter but not the former. Boyle, however, approached so far towards the discovery of repulsion, that he remarked, that feathers and other light bodies would cling to his fingers after they had been attracted by electrics.

FURTHER PROGRESS.

Otto Guericke, who lived contemporary with Mr. Boyle, and who is famed for his invention of the air pump, made still further discoveries and improvements. He made use of a sulphur globe, whirled on an axis much in the same way with our present glass globes. By this apparatus he could accumulate a greater amount of electricity than had hitherto been accumulated, and was, therefore, enabled to experiment with greater success and certainty than his predecessors. To him is due the honor of making the first full and satisfactory discovery of electric repulsion. "A body once attracted," says he, "by an excited electric, is repelled by it, and not attracted again, until it has touched some other body." He kept a feather for a long time suspended in the air above his sulphur

globe, and made also the remarkable discovery, that, when repelled by an excited body, it always keeps the same face towards that body, as the moon does towards the earth.

Both Mr. Boyle, and Otto Guericke discovered the electric light, simultaneously ; the one, as he supposed, in the diamond, and the other in his excited globe.

DR. WALL'S DISCOVERIES.

Dr. Wall, about the same time, discovered it in a still more satisfactory manner, which we will give in his own words.

"I found," says he, "upon swiftly drawing a well-polished piece of amber in the dark, through a piece of woollen cloth, and squeezing it pretty hard with my hand a prodigious number of little cracklings were heard, and every one of them produced a flash of light, but when the amber was drawn gently and slightly through the cloth, it produced only a light, but no crackling ; but by holding one's finger at a little distance from the amber, a large crackling is produced, with a great flash of light succeeding it. And, what to me is very surprising, upon its eruption, it strikes the finger very sensibly, wheresoever applied, with a push or a puff like wind. This light and crackling seems, in some respects, to represent thunder and lightning."

NEWTON.

Sir Isaac Newton next made the discovery of a fact, which has often been disputed, but which is very necessary in establishing the theory which we assume, that both electric attraction and repulsion will penetrate through glass.

HAWKESBY.

Mr. Hawkesby next in chronological order, wrote, in 1709, a treatise on electricity, in which he published a variety of new facts with regard to attraction and repulsion, and the nature of electric light, supposing it to be phosphoric. Others, who first observed it, at this period, adopted the same opinion.

ELECTRICS AND NON-ELECTRICS.

About twenty years after, when the excitement produced among scholars, by Newton's wonderful discoveries in Natural Philosophy, had, in a measure subsided, Mr. Grey turned his attention to the subject of electricity, and by him was discovered the *distinction* which exists between electrics and non-electrics, forming a new era in the history of the science. But as a detailed account of the interesting experiments, which he made and published in the Philosophical Transactions for 1729, would be altogether too voluminous for the circumscribed limits of the present work, we shall simply allude to the fact, and pass on to the

A NEW PHILOSOPHY OF MATTER.

eration of other important topics and experi-

As far we have glanced rapidly, and, in as brief a manner as we well could, at the history of the rise and progress of this science, and less than this we could well have done, consisted in a thorough examination of the subject. And what is the sum of our investigation thus far? It is this.

Number and a great variety of other substances are capable of exhibiting electrical phenomena. Friction, generally speaking, the cause of the exhibition of these phenomena. When they are made by friction to exhibit those appearances, they are said to be electrically excited, and the power of attraction which they then exhibit over contiguous light bodies is denominated electrical attraction.

REPULSION.

But this is not the only power manifested, or the only power exerted, by this agent, over bodies or in connection with their own properties. There is a *repulsive* as well as an *attractive* force. This attraction and repulsion, depend, as will be seen, upon the different electrical states of different bodies.

EXPERIMENTS.

For illustration, rub a glass tube. It becomes electrically excited. Hold it over little bits of paper.

They are attracted towards it from some distance, and

with considerable force. But you perceive that the moment they come in contact, they receive a portion of the electricity, which attracted them, and are immediately repelled. Dropping, however, upon some other substance, they impart to that substance a portion of the electricity, which they receive from the glass and are again attracted towards it, though with less force than before, because it is less excited than before, having in the first contact lost a portion of its superabundant electricity. This alternate attraction and repulsion continues, though more and more feebly, until the excited substance has lost entirely its electric charge, and has returned to its natural state. It then exhibits no attractive powers whatever. Contiguous light bodies, however light and easily moved, remain perfectly unaffected and quiescent at its approach.

Another piece of apparatus, by which attraction and repulsion are still more forcibly and amusingly illustrated, is what is called the apparatus for the dancing figures, by which, pieces of paper, or images cut from paste board, or pith of elder, are made to dance between two plates, by the action and reaction of positive and negative electricities.

WONDERFUL, THOUGH COMMON.

How wonderful the agency here exhibited? Who does not look with astonishment upon the mock creative and life-giving energy which electricity displays? Had some chemist made an exhibition like this in the

dark ages, without explanation, or even in the days of Salem witchcraft, it would have rung throughout the country that he had made a league with the evil one, and he would, as a compensation for his wisdom and wit, have stood a pretty good chance to get a roasting for a wizard. There is a case on record directly in point. John Faust, an ingenious German, by the invention of types, was enabled, during the dark ages, not only to publish books much faster, but also much *cheaper* than before. This newly discovered art he kept secret for a time, and hence originated the nursery legend of *Dr. Faustus and the devil*, in which he is represented as calling to his aid unlawfully the spirit of darkness.

NON-ELECTRICS.

There are many substances—all the metals in particular—which do not seem to be capable of being electrically excited by friction. The reason, however, is obvious. They give a free passage over their surface to the electricity as it is excited, and it is instantly dissipated without being accumulated in any perceptible quantity.

These are denominated non-electrics, from the fact that they are not capable of being excited like glass and the resins. They are also called conductors, from the fact that they readily transmit the subtle agent without accumulation upon their surface. But it is

only because they are good conductors that they happen to be non-electrics.

HOW MADE ELECTRICS.

Let them be insulated—that is, let them be placed upon some electric or non-conductor, such as glass or gum lac, and they immediately become electrics by friction, or by the communication of the positive charge from the electric machine, and exhibit the same phenomena as glass, sealing wax, or any other excited electric. The reason then, why some substances are electrics, and some non-electrics, is because some substances seem to have a greater power of affinity to retain what is collected upon their surface than others.

The body of a living person, for instance is one of the best conductors of electricity, or non-electrics, and yet it can be made a most perfect electric by insulation.

PROPOSITIONS.

Our observations thus far, aided by our experiments, have been the means of ascertaining these three facts.

1st. *Bodies electrically excited attract bodies unexcited.*

2d. *Two bodies electrically excited, as when one excited body has imparted a portion of its electricity to an unexcited body, mutually repel each other. And,*

3d. *Two in their natural state have no perceptible influence upon each other, but are perfectly quiescent.*

It follows, then, as a matter of course, that these

three facts lay the foundation for three distinct propositions :

1st. *Opposite electrical states attract.*

2d. *Similar electrical states repel.* And,

3d. *When bodies are in their natural state, they are in a perfect equilibrium, or a balance, exerting neither an attractive nor a repulsive influence.*

CHAPTER V.

A QUESTION FOR DISCUSSION.

THE question here naturally suggests itself—What are those two opposite electrical states spoken of in the proposition near the close of the last chapter? Are they two distinct electrical fluids, or only one? We here use the term fluids, not because we consider it an appropriate term, for we cannot conceive that the word fluidity, in its general acceptation, conveys a correct idea of the movement of electricity, but we use it simply in accommodation to the inappropriate phraseology of those standard works, from the theories of which we are obliged to dissent. Are the opposite electrical states, we say, then, two distinct fluids, speaking in the language of the books, or only one? Eminent philosophers have been divided upon this point. While Dufay, Symmer, Coulomb, Turner, Thompson, and others, believed that there are two, with opposite inherent natures, Dr. Franklin, Epinus and Cavendish, with some modification of each others views, maintained as positively that there is but one.

BOTH THEORIES EXAMINED.

We will first state briefly the peculiar views of these two classes of celebrated opponents, examine very

minutely their arguments, show how far we agree with them, wherein we differ, and the reasons which compel us to differ. Our object in thus minutely investigating those two theories and in attempting to ascertain the truth in the case, is to lay broadly and permanently, upon the immoveable and imperishable basis of fact and argument, the foundation of that system of philosophy, the superstructure of which will be built up in the course of this work. An error, or a doubt, or an uncertainty *here*, will be of serious detriment throughout the whole series, for our theory must stand or fall by the stability or instability of the foundation which we here lay.

THEORY OF TWO FLUIDS.

The theorists who maintained the existence of two fluids gave their supposed opposite electricities the names of *vitreous* and *resinous*. They called the one *vitreous* because developed, as they supposed, in glass, the word being derived from a Latin term which denotes glass, and the other *resinous*, because developed, as they supposed, in sealing wax, Gum Lac, and other resins, and those two were supposed by them to possess properties entirely and inherently different from each other, each attractive to its opposite and repellent to itself. Upon this hypothesis they attempted to explain the reason why an excited body attracts an unexcited body, and why like amounts of like electricities, either vitreous or resinous, mutually repel each other.

CONSIDERED UNPHILOSOPHICAL.

But, as we shall be under the necessity, with our views on the subject, to differ entirely from their hypothesis, we will let them first speak in full for themselves, and then endeavor to show wherein that hypothesis clashes with fact. And that there may be no injustice done to those theorists, we will quote the language of one of their most learned and eminent champions. Dr. Turner, in his "Elements of Chemistry," on pages 72 and 73, thus speaks :

TURNER'S OPINION.

"On comparing the electric properties manifested by glass and sealing-wax, when both are rubbed by a woollen or silk cloth, they will be found essentially different, and hence it is inferred that there are two kinds or states of electricity, one termed *vitreous*, because developed on glass, and the other *resinous* electricity, from being first noticed on resinous substances. These two kinds of electricity, one or other of which is possessed by every electrified substance, are also termed *positive* and *negative*, the terms *vitreous* and *positive* being used synonymously, as are *resinous* and *negative*. The mode of distinguishing between positive and negative electricity is founded on the circumstance, that if two electrified substances are both positive or both negative, they are invariably disposed to recede from each other, that is, to exhibit electric repulsion ; but if one be positive and the other

negative, their mutual action is as constantly attractive. The end of a silk thread, after contact with an electrified stick of sealing-wax, is repelled by the wax, because both are in the same electric state ; but if a dry, warm wine-glass be rubbed with cloth or silk, and then presented to the thread, attraction will ensue. A silk thread, in a *known* electric state, thus indicates the kind of electricity possessed by other substances. A convenient mode of doing this is to draw a thread of white silk rapidly through a fold of coarse brown paper, previously warmed, by which means its whole length will be rendered positive.

“ When two substances are rubbed together so as to electrify one of them, the other, if in a state to retain electricity, will be excited also, one being always negative and the other positive. It is easy to be satisfied of this by very simple experiments. Rub a stick of sealing-wax on warm coarse brown paper, and the paper will be found to repel a positively excited thread of silk, while the wax will attract it ; if a warm wine-glass be rubbed on the brown paper, the glass will be positive, as shown by its repelling the positive thread, while the same thread will be attracted by the negative paper ; friction of sealing-wax on a silk riband renders the riband positive, but with glass the riband is negative. If two silk ribands, one white and the other black, be made quite warm, placed in contact, and then drawn quickly through the closed fingers, they will be found on separation to be highly attract-

ive to each other, the white being positive and the black negative. The back of a cat is positive to all substances with which it has been tried, and smooth glass is positive to all except the back of a cat. Sealing-wax is negative to all the substances just enumerated, but becomes positive by friction with most of the metals. The reader will perceive from these facts that the same substance may acquire both kinds of electricity, becoming positive by friction with one body, and negative with another."

"This theory, the fundamental facts of which were supplied partly by Dufay, and partly by Symmer, is founded on the assumed existence of two electric fluids, which Dufay distinguished by the terms *vitreous* and *resinous* electricity. In order to account for electric phenomena by this supposition, the two fluids are assumed to possess the following properties: They are both equally subtile and elastic, universally diffused, and, therefore, present in all bodies, possessed of the most perfect fluidity, each highly repulsive to its own particles, and as highly attractive to those of the opposite kind; these attractive and repulsive forces being exactly equal at the same distance, and both varying inversely as the squares of the distance vary."

"Electric quiescence is ascribed to these fluids being combined and neutralized with each other; and electric excitation is the consequence of either fluid being in excess. Their combination is destroyed by several causes, of which friction is one. The application of

these principles is as follows. Two unexcited contiguous bodies, A and B, are electrically indifferent to each other; for, though each electricity in A repels the electricity of the same name in B, attraction to the same extent is exerted between the opposite electricities, and no change results. If A and B are rubbed together, a portion of the combined electricities in both is decomposed, and the separated resinous fluid is transferred to one of them, suppose to A, and the vitreous to B, each being electrified to the same degree, though oppositely. The free particles of resinous electricity in A tend by their repulsion to recede from each other, and would quit A altogether, unless their passage was impeded by a non-conductor; the atmosphere, if dry, cuts off the retreat, and by its pressure confines the resinous fluid to the surface of A. The same happens to the vitreous fluid on the surface of B. But the opposite electricities fixed on A and B exert a strong mutual attraction, and may succeed either in forcing their way across the intervening stratum of air, or of actually drawing A and B into contact. In either case the free electricities reunite, and the electric equilibrium is restored. On the contrary, if A and B are similarly electrified, that is, possess the same kind of free electricity, the effort of the electric fluid to escape in opposite directions causes the substances themselves to fly asunder, if the repulsive force exceed their weight, and thus produces electric repulsion."

"This theory, as commonly stated, takes little or no cognizance of any attraction between the electric fluids and other material substances. But it would be against all analogy to suppose no such influence to exist; and indeed the supposition of an attractive force acting at insensible distances seems necessary to account for the impediment caused by non-conductors to the free movement of the electric fluids."

THEORY OF ONE FLUID.

Dr. Franklin, the celebrated electrician of our own country, took strong and decided ground against this doctrine. For it, he substituted the more simple theory of one fluid, and attempted to account for all the various phenomena of attraction and repulsion by the different states or degrees, or volumes of electricity, which he called *plus* or *positive* and *minus* or *negative*. When a body had more than its natural share, it was considered to be in a plus or positive state, and when it had less than its natural share it was considered minus or negative. Bodies, upon this principle, are positive and negative relatively, or positive and negative *absolutely*. They are positive and negative *relatively* when they are both plus, but when one has a greater amount than the other. They are positive and negative *absolutely* when one has *more* than its natural share, and the other less. But in each of those cases there is attraction, though much more feeble in the former than in the latter case.

A DIFFICULTY.

Franklin, however, found, after mature reflection upon the subject, that his theory was attended with one inexplicable difficulty. His penetrating mind could not solve it satisfactorily to himself. This difficulty was the repulsion of *two negatives*, which he confessed could not be explained upon the plus and minus theory, for in this case both would be minus, and there, of course, be an absence of what he considered to be the attractive and repulsive principle.

ATTEMPT TO SOLVE THE DIFFICULTY.

Epinus, however, a celebrated electrician of St. Petersburg, in Russia, undertook to extricate the theory of Franklin from this dilemma. He maintained with Franklin, that there is but one fluid, and accounted for all the phenomena of attraction and repulsion, including the repulsion of two negatives, upon the hypothesis that there must be a reciprocal affinity or attraction between ponderable and imponderable matter, and that the particles of each must be mutually repellent to those of their own kind, and mutually attractive to their opposites, and that this attraction and repulsion exerts itself in the ratio of inverse proportions according to the squares of the distance. This, it will be seen, lays the basis for three distinct propositions.

PROPOSITIONS.

1st. The particles, or ultimate atoms of ponderable matter mutually repel each other.

2d. The particles or component parts of imponderable matter, or electricity, mutually repel each other.

3d. The particles or component parts of both ponderable and imponderable matter mutually attract their opposites, and that, too, with a force which not only varies according to the squares of the distance, but, also, according to the magnitude and density of the one, and the volume or degree of the other.

EXPLANATION UNSATISFACTORY.

Now from this explanation of the difficulty, which Franklin encountered, we dissent altogether. It destroys virtually that "*vis-inertia*" or inaction, which is an essential property of ponderable matter, and gives to it attributes, which it never possessed. That difficulty can be explained in a manner more strictly in accordance with fact, for the theory of one electric agent, as maintained by Franklin, is correct—his doctrine of plus and minus is also correct—but there are certain invariable *results*, which depend upon the plus and minus of bodies, which will fully explain the difficulty, which he encountered. We must look, not to the simple volume or degree, or amount of accumulation itself—not to the simple plus and minus, but to the *organic laws of the ultimate component particles of*

electricity, for the solution of the enigma, which so puzzled Franklin—which laws, however, invariably exhibit their operations through the medium of a plus and minus, as Franklin supposed; for all the electrical phenomena depend, after all, upon a plus and minus in bodies.

DISCUSSION DEFERRED TO NEXT CHAPTER.

Lest the present chapter should be extended too far, we are obliged to defer to the next the full examination of the two opposing theories, which have been stated, and shall show wherein we are under the necessity in many respects of differing from both, by the existence of a formidable array of facts, and the arguments which can be legitimately drawn from them, which facts and arguments, in our view, preclude the *possibility* of their being correct. The theory of two fluids in particular, seems to us so wide from the truth, and so contrary to known and tested laws, that we are somewhat surprised that men of such acknowledged talent and intellectual acumen, as they confessedly are, who advocate them, should ever have given them credence or currency. It must, we believe, in some cases, have been from the fact that they admitted, without examination, upon the mere authority of great names, what they should have thoroughly examined for themselves, unbiassed by preconceived opinions, and promptly rejected, if they found the same unsubstantiated by fact. It is unsafe either to regard great names as

infallible or to indulge in fanciful philosophical speculations, which have no solid and imperishable basis in the stern and sober reality of things. Whether that stern and sober reality have an existence or not in any given case, can be ascertained, in most instances, by experiment. In combating those errors in theory, we shall draw all our conclusions from the facts which experiment furnishes.

CHAPTER VI.

DISCUSSION CONTINUED.

As announced in the former chapter, the present will partake largely of a controversial character. Yet, we differ with those authors, from whose opinions we shall dissent, *only* because the *facts*, which have been ascertained by ourselves and by others, in the careful observations of the laboratory, *compel* us to differ. And, while we thus differ, we entertain the highest respect for the talents and researches of those eminent scholars. They have thrown great light upon many abstruse and difficult subjects, and we are free and happy to acknowledge the benefit and assistance which we have received from their works.

DIVERSITY OF OPINION NOT STRANGE.

It is not at all wonderful that there should be diverse and clashing opinions upon the subject of electricity, and its various phenomena and influences, since it is an agent so extremely subtle, and since it must be acknowledged that it is not easy to detect, in many instances, the "*modus operandi*" of its doings, or the primary cause of some of the effects it exhibits. Our arguments and conclusions will, therefore, be liable to misapprehension and misinterpretation, v

great pains be taken to render them as clear and lucid as it is possible for language to make them ; and, even then, we do not expect to escape entirely the common fate of authors, owing to the imperfection of the fallible medium through which ideas are conveyed from one mind to another. That we may, therefore, avoid as much as possible misapprehension, and that the positions to be examined, as well as controverted, may be vividly before the mind of the reader, we will restate them briefly before proceeding in the discussion.

We shall do it, also, for another important reason. The opinions advanced in the following pages will be substantiated, or proved baseless and erroneous, as we establish or *fail* to establish our positions. Much, therefore, it will be seen, depends upon a thorough examination of the opposing and clashing theories of one and two electric agents, and upon the full and satisfactory establishment of the one, and refutation of the other, and, for this reason, we here define the precise position of the combatants, even at the risk and expense of being thought somewhat diffuse and tautological.

RECAPITULATION.

Dufay, Symmer, Coulomb, Turner, and Thompson, promulgated and defended the theory that there are two kinds of electricity, or two distinct electrical agents ; that one, if we can understand them aright, resides *inherently* in one substance and the other *inhe-*

rently in another ; that each of those two agents is mutually repellent to itself, and mutually attractive to its opposite ; and that all the phenomena of attraction and repulsion among bodies are produced by the action or agency of these two electricities.

That it may not be affirmed by the advocates of this theory, that we have mis-stated their opinions upon this point, when their glaring erroneousness and absurdity shall have been made to appear, or stand out prominently to view, even by *their own showing*, and their own *self-contradictions*, we will give their own language. Thompson thus speaks of this subject upon the 359th and 360th pages of his large work on Heat and Electricity.

ILLUSTRATION BY THOMPSON.

“ If we suspend two small pith balls, by means of a very slender wire from a stick of sealing-wax, and rub the wax with dry woollen cloth, the two balls will repel each other. If we suspend another pith ball by a slender wire from a stick of sealing-wax, and rub it also with a dry woollen cloth, this pith ball, if brought close to the two former, will also be repelled by them. If we suspend the pith balls by slender wires from dry glass tubes, and rub the tubes with dry woollen cloth, the result will be the same—all the pith balls will repel each other.

“ But if we suspend a small pith ball by a small wire from a glass tube, and another in a similar manner

from a stick of sealing-wax, and make the two balls approach, after having rubbed the glass tube, and the stick of sealing-wax, the pith balls, instead of repelling, will *attract* each other."

FACTS TRUE, BUT CONCLUSIONS FALSE.

Now these facts, which Thompson records, as having been proven by experiment, we pretend not to deny. They are doubtless true. But we deny, altogether, the *conclusions* which he draws from these, as his data or premises. He thus reasons :

"Hence it is obvious, that the electricity excited in glass" [now mark this] "is *different* from that excited in sealing-wax, since bodies having the *electricity* of *glass* attract those having the electricity of sealing-wax, while bodies having each either the electricity of glass or sealing-wax repel each other."

Now it has been affirmed by some of the advocates of the theory of two agents, that Thompson did not say, in this passage, or *intend* to say, that glass produces *only one kind*, and sealing-wax *only* the other. But if he does not, by the quotation already made, advance such an opinion, we must confess ourself utterly incapable of understanding his language. Our intellectual acumen happens not to be sharp enough, if that be the case, to perceive his meaning.

ANALYSIS.

Let us examine and dissect the passage a little, for our object is to get at the facts in the case, and elicit truth, and sift it from error. Thompson expressly affirms without any qualification, that the electricity of glass is *different* from that of sealing-wax. He does not intimate that he considers it to contain any other than that which he says is different. The assumption that he does, for the sake of getting him out of a dilemma, is supplying, by an active imagination, what he has not seen fit even to *hint* at in any of his labored works. Before showing what the dilemma is, from which his apologists would extricate his theory—before placing in striking contrast his palpable *self-contradictions*, and making him refute himself, scholar as he certainly is, we will quote from Turner, another of the most able defenders of the theory we are opposing, to show that Thompson stands not alone in the advocacy of such sentiments.

TURNER'S ARGUMENT.

He says, on page 72 of his Chemistry, as quoted in the former part of this work, "on comparing the electric properties manifested by glass and sealing-wax, when both are rubbed by a woollen or silk cloth, they will be found *essentially* different, and hence it is inferred that there are two kinds of states or electricity, one termed *vitreous*"—and why? Mark the answer

of Turner—"Because developed in glass. And the other *resinous*"—and why?—"Because first noticed in resinous substances." Now, is there the slightest intimation in this statement of the theory, that glass ever develops but one kind, or resinous, substances either? Does he not rather expressly affirm that they are *essentially* different, and if one thing be *essentially* different from another, what logician will insinuate that they are alike?

SELF-CONTRADICTIONS.

Now then for the self-contradictions of the staunchest and most learned advocate of this palpable error in theory. Let Mr. Thompson be arrayed against Mr. Thompson, and let him be refuted by his own statement of facts. There can be no *fairer* system of polemic warfare.

On page 361 of Thompson, he has the following language: "If we rub dry woollen cloth against smooth glass, it acquires resinous electricity: while the glass becomes *positively* electrified. But if we rub woollen cloth against rough glass, it acquires positive electricity, while the glass is charged with negative or resinous electricity.

Now in this quotation Thompson certainly contradicts his assertions in other parts of his work, if I am able to decypher the meaning of an author. He affirms in the quotation already dissected and analyzed, that "the electricity of glass is *different*, from that of seal-

ing-wax," and in the facts last quoted, he proves that, with the same materials and with the same rubber, both the electricities are developed in glass, and that at least one of its electricities, if it have two, is the same as in sealing-wax, instead of being "*essentially different*," as elsewhere asserted.

This palpable *self-contradiction* arises from the fact that he has undertaken to defend the fanciful speculations of an active imagination, which, as a general thing, passed too much in his day for current truth.

THE APOLOGIST.

But, some one may say, that although a palpable contradiction has been detected, yet that should not impair confidence in the doctrine of two agents. Such an one may affirm that by rubbing glass one kind of electricity may be drawn from it, and that by rubbing with the same rubber glass of another kind of surface, another kind of electricity may be developed.

Although the bare proposition, to our mind, seems most superlatively illogical and ridiculous, yet we will examine it, because it seems to be seriously and honestly believed by its advocates.


THE ILLOGICAL ASSUMPTION ANALYZED.

If it be maintained that there are two electric agents or *fluids*, as they are called, and that they have an attraction for each other, and a repulsion for themselves, they must, according to the facts which Mr.

Thompson himself has recorded, both reside in glass. Now if that be the case, and if they both, as asserted, have a mutual attraction for each other, why should friction call the positive current out of smooth glass, and leave the negative, or why should it call the negative out of rough glass, and leave the positive?

It may be said by some one, perhaps, that it *does* call both out, but that the one current runs to the surface of the woollen rubber, while the other accumulates upon the surface of the glass. But why should they do this? If there be two currents of the kind we are examining—if they have a *mutual attraction* for each other, and if friction calls forth both of them at the same time, why should they not, by the force of that attraction, both accumulate upon the same surface?

And, to show still further the mere fanciful nature of this theory, when brought to the test of fact and of reason, why should a dry woollen rubber accumulate upon itself negative electricity when rubbed against *smooth* glass, and positive electricity when rubbed against *rough* glass? and why should the smooth glass acquire positive and the rough negative at the same time? Not one of these questions can be answered satisfactorily upon the supposition of *two* fluids.



CHAPTER VII.

ONE FLUID.

WE have to resort to the theory of one fluid to account for these things rationally, though not to the theory of one fluid exactly, as taught in the books. Positive and negative, then, does not depend upon the influence of two electricities inherently different, but upon the different degrees of the accumulation of a single current. If a substance, by any cause, acquires *more* than a certain amount, so as to make it plus, with regard to what may be called its natural share, it is positive, but if it have *less* than a certain amount, so as to make it *minus*, it is negative ; and so positive and negative relate to degree or quantity, and to degree or quantity *alone*.

HARMONIZES WITH FACTS.

Upon this hypothesis, the reason why, in the facts quoted from Thompson, the woollen became positive in one case, and the glass negative, and why in the other case the woollen became negative and the glass positive, was simply because the roughest of two substances, when rubbed together, if both be non-conductors, will impart its electricity to the other, and make

that plus, or positive, while it becomes minus, or negative, and just to the extent that the one is positive, just to that extent is the other negative ; so that the one invariably accumulates precisely what the other loses. *This law is universal.* If one substance loses its electricity, just in that proportion *precisely* does the other accumulate it. Not an iota is created by friction ; its quiet is only disturbed, and if it accumulates, it is evident that the substance from which it is accumulated is so far minus.

This accounts rationally, and in accordance with that simplicity and economy which appears throughout nature, for all the phenomena of positive and negative electricity. It is simply accumulation and proportional abstraction.

A DIFFICULT PROBLEM.

But the reason why two positives repel, a positive and negative, and a negative and positive attract, and why two negatives repel, is much more abstruse. It has for a long time puzzled philosophers. Franklin, clear headed as he was, found himself in a dilemma, and confessed it, when endeavoring to solve the mystery of the repulsion of two negatives. Nor is the attempt of Epinus to extricate him from the difficulty, entirely satisfactory, although we far prefer it to the irrational and palpable contradictions which cluster thickly around the theory of two electric agents.

EPINUS'S THEORY.

The opinions of Franklin, reconciled by Epinus, are based upon three propositions, which we stated in a former chapter :

- 1st. Ponderable matter repels its own particles.
- 2d. Imponderable matter repels its own particles.
- 3d. They have a mutual attraction for each other.

CONTRARY TO FACT.

But this again might seem to convey the idea that ponderable matter, by its attraction, exhibits inherent activity, which is contrary to fact; for ponderable matter of itself we hold to be perfectly inert. We must examine further, then, to find a philosophical solution for the enigma. Such a solution we think we have found. It is nowhere even hinted at in the books. But because it is not, let no one suppose that we are about to advance a mere fanciful hypothesis, based on no solid foundation of fact.

OUR SOLUTION.

Our solution of the difficulty will be derived from a law of electricity, which, although it seems to have escaped the attention of chemists, can nevertheless be demonstrated to exist, as easily and as perfectly as any problem in Euclid can be demonstrated. It is this. Every ultimate particle of electricity has opposite polarities; that is, each end of each individual

particle has a different property ; *like* ends or polarities repel, and *unlike* ends or polarities attract.

AN AXIOM.

This we intend to prove conclusively by the aid of that immutable truth, that *the laws of the whole are the laws of its parts*, and, by the operation of the rule so proven, we intend to show that all the phenomena of attraction and repulsion among both atoms and planets can be rationally accounted for. Let us apply the immutable and infallible rule, that the laws of the whole are the laws of its parts, and *see* whether it will sustain the opinion we have hazarded, and for which we derive no support from the books.

PROOFS.

Electricity and galvanism are, at the present day, generally conceded to be the same agent. There is no dispute about that. Now, if you pass a current of galvanism around soft iron, bent into the form of a horse-shoe, and wound spirally with insulated copper wire, you make the iron magnetic, and the two ends have different polarities. By different polarities, we mean, that what one end will attract the other will repel, or the one is negative and the other is positive. But by changing the poles of the battery and passing the current of electricity in a different direction around the spiral wire, you change the polarity of the iron, and make the end that was positive, negative,

and the end that was negative, positive, which can be shown by experiments in electro-magnetism. So then positive and negative, in this case, depend upon the direction in which the current runs; for the current runs *inward* at one end and outward at the other. The end where the current is *inward* is *always negative*, and that where it is *outward* is *always positive*. And why is this invariably so? There must be a reason for this phenomenon. Its solution is readily found in the admirable and infallible rule, that the *laws of the whole are the laws of its parts*. If a current of electricity, running in a certain direction, makes one end of a bar of iron positive and the other negative, each individual ultimate particle of that current must have an agency in producing such a result, and, therefore, each individual particle must have a positive and negative end, the positive end always leading, and the negative, of course, always following. We infer this from the fact that the laws of the whole are the laws of its parts, or the laws of its parts are the laws of the whole; for it would be utterly impossible that the whole of a thing should have a quality the *opposite* of the *parts* of which it is composed.

FURTHER ILLUSTRATIONS.

To make our position still more impregnable by fact and argument, let us examine further. If you pass the galvanic current around steel spirally, in the same way as it is passed around soft iron, you make it

permanently magnetic. The end where the current is *inward* is *negative*, but the end where it is *outward* is *positive*. So it will remain for years. Now you may cut up that bar of steel, which is thus made magnetic, into ten thousand *pieces*, and *each piece* will have a positive and negative end, and the positive and negative polarities of the pieces will be arranged in the same direction as in the whole. What, then, is the unavoidable and logical inference? Why, that *each ultimate particle of the electricity* that made it magnetic and keeps it magnetic has *opposite polarities*, as well as the whole current, because the properties of the whole are, most assuredly, made up of the properties of its parts.

A mere thimble full of the atmosphere, for instance, contains its relative proportions of oxygen and nitrogen, as well as the whole mass. A drop of water contains its relative proportions of oxygen and hydrogen, as well as the ocean, and so with every thing else.

Having, by fact and by argument, attempted to prove that each end of the ultimate particles of electricity has opposite polarities, that the positive end is always presented in the outward current, and the negative end, of course, in the inward current, we will now apply this theory to the explanation of the phenomena of attraction and repulsion. But first, to show that the facts are true which we have stated, we can prove them by an experiment with two magnets.

EXPERIMENT WITH TWO MAGNETS.

If, for illustration, two steel magnets, with like powers, be dipped into iron filings, until they have accumulated as large an amount as they can retain upon their poles, and the opposite poles of each be then presented within a short distance of each other, the filings will spin out, and fill up the space between them, and exhibit an oily, ropy appearance; but, if like poles be presented, the filings will be blown back, as it were, and stand out like hair around the poles of the magnet. This shows that there is attraction in the one case and repulsion in the other.

APPLICATION OF THESE FACTS.

Now, then, for an explanation of the attractions and repulsions of common electricity by this theory. A body which is charged plus, or positive, has an emanation or an outward current. Such a body will attract a body charged minus, or negative. And why? Because, as we have shown by the magnets, the outward current of the body charged plus presents its positive end. But a body in a minus state has an inward current of electricity, which it attracts from contiguous substances. Of course the negative end of the ultimate particles of this inward current is presented. And what is the consequence? Why two bodies, the one having an outward and the other an inward current, present opposite polarities to each other, and are

attracted from the operation of the immutable law, that opposite polarities attract.

SOLUTION OF A DIFFICULT PROBLEM.

We now come to the solution of that difficulty which perplexed Dr. Franklin so much—the repulsion of two negatives. Before the application of this rule the difficulty vanishes at once. When two bodies are minus, or have *less* than their natural share, the current of electricity is inward into both. Now if, while the two currents are inward, the bodies in a minus state be brought near each other, they are repelled, because, both currents being inward, the negative ends of the ultimate particles are presented to each other, and they are repelled upon the principle that like polarities repel each other. Thus is all attraction and repulsion among material bodies, and, of course, all motion produced by the agency of electricity alone, without the intervention or coöperation of inert matter, accounted for. So that the difficulty which Dr. Franklin encountered in his theory of plus and minus, is obviated without the aid of the unphilosophical assumption of Epinus and Cavendish, that matter has the property of repelling its own particles.

OBJECTION ANSWERED.

But an objection may possibly arise in the mind of some, respecting the repulsion of two negatives, which we will state in the form of a question, and then answer

it. If the current of electricity be *inward* into two bodies, why should not the force of the currents setting in, bring two bodies together? Such a question would be asked by an objector, who did not understand fully the relative agency of electricity over inert matter. Motion is never produced in ponderable matter by the mere force of moving currents of electricity. If this was the case, our earth would have been instantaneously battered to atoms by the light, which first struck it from the sun. The force of the currents is not a moving cause at all. So subtle are they, that they make no impression of this sort upon matter. But their attractions and repulsions all depend upon an organic law of the ultimate particles—upon polarity, and upon that alone.

PROOFS.

There are several other facts illustrative of this law. The upper end of a lightning rod, for instance, is negative, while the lower end is positive. And why? Because the current is towards the earth, and is, therefore, inward at the top and outward at the bottom. Unless this were the case, it would not have a tendency to draw electricity from the clouds, but repel it.

The shovel, tongs, poker or any other metallic rod or substance which has stood for some time in an upright position, whether in the chimney corner, or in any other upright position—whether within or without the house—imbibe electric properties, and

their two extremities always exhibit opposite polarities. This is demonstrated by the fact, that one end will draw the north point of the needle of the compass, while the other end will drive it.


As opposite polarities always attract, we find by this experiment, that the top of such a metallic rod is negative, because it attracts the positive end of the needle, and the bottom positive, because it repels the north point of the needle, upon the principle that like polarities repel.

LOGICAL INFERENCES.

The longer a metallic rod remains in an upright position, the stronger does its electric, or magnetic properties become, until it has become as completely saturated with the wondrous agent, as it can be. Now the question naturally suggests itself, as to the exciting cause of this invariable electric, or magnetic property. Why is the top of a metallic bar or rod, which has stood in an upright position for a long time, always negative, and its bottom always positive, or in other words, why is the stream of electric influence always *inward* at the top, and *outward* at the bottom? Whence does it come? From the sun, undoubtedly, in the passage of the rays of that electrifying agent to the earth, as we shall show more fully when we come to the subject of light. If any chemist can account for the phenomenon more philosophically, we should be pleased to have his solution of the problem.

BENEFITS OF ELECTRICAL DISCOVERIES.

Having fully and minutely examined the theory of one and two fluids, and described what we consider to be the true and *only* true cause of all attractions and repulsions in nature, we must now, in order to render a treatise upon this subject *complete*, just glance at some of the principal benefits, which have been conferred upon the world by the investigations of electricians, which investigations, were some of them made at great personal risk, as will appear in the sequel. But we will refer these to the next chapter.



CHAPTER VIII.

LEYDEN JAR.

The Leyden Jar is an article of electric apparatus, which was invented by Cunæus, Muschenbrœeck, and Allamand, at a very early period of electrical science. But, as it is in common use, in all experiments illustrative of this subject, and as it is fully described in the text-books, we shall just pass with a mere allusion to it.

INFERENCES.

After its discovery, and the exhibition of the powerful effects of electrical batteries, philosophers could not avoid perceiving the analogy, which evidently exists between electricity and lightning. This led to intense investigations of the subtle phenomena of the storm-cloud. Our sagacious Dr. Franklin led the way. Having discovered that pointed rods of the various metals have the power of discharging electricity, when presented at some distance from the knob of the Leyden jar, the thought occurred to his mind, that atmospheric electricity might, by means of that discovery, be made *sensible*. This thought was communicated to M. D'Abilard, of France, and some other electricians

of Europe, with the request that they would test the correctness of his opinions by some experiment, as their facilities for procuring suitable apparatus were superior to his own. Following his suggestion, observations were eagerly made by several, and his opinions were proven to be well founded.

FRANKLIN'S EXPERIMENTS.

In the mean time, however, and before he had received any account of the experiments made in Europe, it occurred to Franklin, that, by means of a common kite, he could have access to the floating reservoirs of thunder. Having, therefore, prepared one, with a large silk handkerchief, having two cross sticks, he, with no confidant but his son, for fear of the ridicule which would attend an unsuccessful experiment, walked out into a secluded field at the approach of the first thunder storm after the completion of his kite, and with the help of his son, raised it into the atmosphere. He waited some time with anxious and breathless expectation. One well charged cloud had passed, and no effect upon his kite was perceptible. Just, however, as he began to despair of success, he noticed that some of the loose threads around his hempen cord, which had, by this time, become a better conductor than at first, owing to the moisture accumulated upon it, would stand out, and apparently avoid each other. Encouraged by this favorable appearance, he presented, though at the risk of his life, his knuckle to the key, which he

had tied to the end of the cord, and received a strong spark, attended with a loud snap. Others more brilliant still and in quick succession followed, and thus was fully proven by Franklin, the identity of electricity, and the lightning of the clouds.

RICHMAN'S EXPERIMENT.

This experiment was unconsciously attended with extreme danger, as was subsequently proven in the fate of the amiable, talented, and lamented Professor Richman, of St. Petersburg. The circumstances of his untimely end are thus detailed by Thompson, in his large work on "Heat and Electricity," on pages 435-6.

"He had provided himself with an instrument, which he called an electrical gnomon, the use of which was to measure the strength of electricity. It consisted of a rod of metal, terminating in a small glass vessel, into which he had (for what reason does not appear,) put some brass filings. At the end of this rod a thread was fastened, which hung down by the side of the rod when it was not electrified, but when it was, it avoided the rod, and stood at a distance from it, making an angle at the place where it was fastened. To measure this angle, he had the arch of a quadrant fastened to the bottom of the iron rod.

MOURNFUL FATE OF RICHMAN.

He was observing the effect of the electricity of the clouds, at the approach of a thunder-storm, upon his

gnomon, and of course standing with his head inclined towards it, accompanied by M. Solokow, (an engraver, whom he frequently took with him to be a joint observer of his electrical experiments, in order to represent them the better in his figures,) when this gentleman, who was standing close to his elbow, observed a globe of blue fire, as he called it, as big as his fist, jump from the rod of the gnomon, towards the head of the Professor, which, at that instant, was about a foot distant from the rod. This flash killed Mr. Richman; but Mr. Solokow could give no account of the particular manner in which he was immediately affected by it. For at the same time that the Professor was struck, there arose a sort of steam, or vapor, which entirely benumbed him, and made him sink down upon the ground, so that he could not remember to have heard the clap of thunder, which was very loud.

EFFECTS OF THE FLASH

The globe of fire was attended with a report as loud as that of a pistol. A wire, which brought the electricity to the metal rod, was broken to pieces, and its fragments thrown upon Mr. Solokow's clothes. Half of the glass vessel, in which the rod of the gnomon stood, was broken off, and the filings of metal that were in it were thrown about the room. The door case of the room was split through, the door torn off, and thrown into the room. The shoe of the Professor's left foot was burst open, and there was a blue mark

on his foot at that place, from which it was concluded that the electricity had entered by the head, where there were evident marks of injury, and made its way out again by the left foot."

FURTHER EXPERIMENTS.

I cannot resist the inclination to make another quotation here, from the same work, respecting the improvements made about this time, and which rendered the experiments with the kite much more safe and satisfactory than before.

"M. de Romas made the experiment with the kite in a more perfect manner than the first attempt of Dr. Franklin. He twisted a fine iron wire into the cord of the kite. To prevent the observer from being exposed to danger, the lower extremity of the string terminated in a silk cord, eight or ten feet in length, by means of which the kite with its strings was insulated. Instead of drawing sparks with the finger, which makes the observer himself receive the charge, he received them by means of a metallic conductor, connected with the ground by a chain which he held in his hand by means of an insulating glass handle, so that it resembled our common discharger. Romas describes the sparks given out from the string to this discharger during a thunder-storm, in a letter to the Abbe Nollet, in very glowing language. 'Conceive,' says he, 'plates of flame nine or ten feet long, and an inch thick, which make as much noise as a pistol. In less

than an hour I had certainly thirty plates of this size, without reckoning a thousand others of seven feet and below that. But what gave me the greatest satisfaction in this new spectacle was, that the greatest of these plates were spontaneous, and that notwithstanding the abundance of the fire which they contained, they fell always on the nearest conductor. This constancy gave me so much security, that I was not afraid to draw sparks by means of my conductor, even when the thunder-storm was at its height, although the glass handle of that instrument was only two feet in length. I conducted where I pleased, without feeling in my hand the smallest commotion, sparks of fire six or seven feet long, with the same facility as those whose length did not exceed seven or eight inches."

LIGHTNING RODS.

From these successful experiments with the kite, the *practical* benefit of lightning-rods, for the protection of edifices exposed to the destruction of the scathing element, was suggested to the active mind of Franklin, who seemed to be always studying to turn science to a profitable account. These were made by elevating above the highest dome or spire, or the chimney of a dwelling, a rod with one or more sharp points, to abstract the fluid from the surrounding atmosphere, in most cases *silently*. Down the sides of the edifice these were conducted, and passed into the ground to a

considerable depth, being fastened to the walls of the building by iron staples driven into them, with some non-conducting substance between them and the rod, to prevent the passage of a bolt into the wall where the staples entered, when the rod happened to be struck by a perceptible flash.

IMPROVEMENTS.

Great improvements have been made, since the invention of Franklin, both in the construction of lightning-rods and in the method of putting them up. By such improvements, they have become much better protectors. They are now made, in some parts of our country, out of square nail-rods, with bearded corners; each joint is made with a ring at one end and a shank at the other, turned outward about two inches, at right angles with the rod, and pointed, which, when put up, is turned outward from the building and inserted in the ring. Thus, each joint, six or eight feet long, has a ring at one end and a shank at the other, which, when connected together, constitute the upright rod. In addition, a square nail-rod is sometimes extended the full length of the ridge-pole, with perpendicular spikes, having sharp points about six inches long, attached to it at an interval of every two or three feet, with branches attached to the same, extending above one or more of the chimneys, if the building be a house, or above the spire if it be a church, and these, so con-

structed, are connected with two upright rods, erected in the manner before described, at each end of the house or edifice, and passing into the ground. Such rods are an ample protection against any thunder-bolt, whether its passage be perpendicular or horizontal.

It might seem appropriate, before closing these chapters upon common electricity, that we should describe the various causes of electrical excitement, show the chemical effects of this powerful and all-pervading agent, and give a solution for the phenomena of winds and storms. But the two former will be reserved for the subject of Galvanism, and the latter for that of Caloric.

We shall, therefore, close this chapter with the request, that the reader would keep distinctly in view the laws by which common electricity is governed; for, by arguments and illustrations, based upon those simple and uniform laws, we expect to establish, beyond controversy or reasonable cavil, the positions which we shall take, in discussing the more abstruse and difficult topics of some of the following chapters. Yes, we shall depend upon those laws to prove that electricity, and electricity alone, is the prime natural cause of all chemical changes in creation, and all motion among either atoms or spheres, or constellations of spheres. We thus call the particular attention of the reader to those laws of electricity, because it will doubtless be the case that many will hesitate to

give the theory credence, and persist in that hesitation, until convinced by demonstrations which are founded upon the self-evident proposition, that "like causes produce like effects."



CHAPTER IX.

RESULTS OF PREVIOUS INVESTIGATION.

By minute and careful investigation, and by a variety of practical experiments with apparatus, we have, thus far, ascertained the immutable laws by which the electrical agent is governed. By this investigation we have ascertained that it can be readily excited, and brought from its mysterious repose into action by friction,

“Quick as spark from smitten steel,
From nitrous grain the blaze.”

Well might its singular development astonish those who first beheld it; for a kind of enchantment seems to linger around the subject. By its instantaneous production, upon the proper application of an exciting cause, we are forcibly reminded of the fabulous legends of magic, though we know it to be reality and not fable. The enchanted ring of Mustapha, the African magician, or the wonderful Lamp of Alladin, when rubbed, brought into the presence of the holder, one of the monstrous Genii of the fables, irresistibly strong but yet perfectly docile, and submissive to the will of the person who thus called him. In the

same manner when friction is applied to the cylinder of glass, forth leaps instantly the subtle and irresistible agent into action and visibility, strong but yet docile as the fabled Genii, a slave to the will even of an intelligent child, standing ready submissively to obey his dictation, and to do his pleasure, if bidden in accordance with its organic laws.

RECAPITULATION.

We have ascertained also, that, under certain circumstances, it invariably exhibits an attractive, and under other circumstances invariably a repulsive power; and that this attraction and repulsion is the cause of all the motions among the particles and light bodies of inert matter—that neither the theory of two fluids, as taught by Turner, Thompson, and others, nor that of one fluid, as taught by Franklin, with the superadded hypothesis of Epinus and Cavendish, account rationally and philosophically for the cause of attraction and repulsion—that that cause is to be found in the constitutional organic laws of the ultimate particles of electricity—that each ultimate particle has opposite polarities, from the fact that a current has opposite polarities, and from the self-evident axiom that the laws of the whole are the laws of its parts—that the outward current or emanation is always positive, because the positive end of the ultimate particles of that current is always presented—that the inward current is, upon the same principle, always negative,

because the negative end of its ultimate particles is always presented—that two outward currents always repel each other, because the positive pole of the ultimate particles of one current are presented to the positive pole of the ultimate particles of the other, and that two inward currents repel for the same reason, because like polarities always repel, whether both be positive or both negative—that an outward current and an inward current, when presented to each other, always attract, from the fact that the positive and negative end of the ultimate particles of those two currents are then presented to each other, and unlike polarities, or positive and negative polarities, always attract. Before this theory, which is capable of absolute demonstration, if there be any certainty in reasoning from the data of self-evident propositions, all difficulties vanish, and every phenomenon of attraction and repulsion can be accounted for philosophically.

UNITY OF THE IMPONDERABLES.

It was assumed at the commencement of this discussion, that all the imponderables are one and the same agent. This we expect to prove to a demonstration, if we can prove that they are all governed by the very same constitutional or organic laws, and that their effects, resulting from the operation of those laws, are the same, which we shall certainly do, if there be any truth in that fundamental principle of logic, that like

causes produce like effects. Having, then, ascertained the laws and agencies—or the causes and effects of the phenomena produced by this indivisible imponderable principle, under one of its appellations, or in one department of its wondrous operations, we will proceed to the examination of the department next in order, which is denominated galvanism. Its history would be the first appropriate object of attention and remark.

GALVANISM.

Galvanism, is so called from Galvani, professor of surgical anatomy at Bologna, who was its reputed discoverer, and a scholar of considerable eminence. Like several other important branches of science, it owes its origin to an accident, which occurred in the year 1791. These were the circumstances of that accident. Mrs. Galvani, at a certain time, during the absence of her husband, observed the effect which electricity exerts upon the muscles of dead animals, through the medium of the nerves, from the accidental contact of the conductor of an electric machine with the crural muscles and lumbar nerve of a frog's leg, which had been dressed for food, and was lying upon a table near the machine in the professor's laboratory. This contact immediately produced violent convulsions in the frog. These, Madame Galvani happened to observe, and related them to her husband upon his return. As he was at that time investigating the subject of animal

electricity, he seized upon the idea with avidity, and repeated the experiment in a variety of ways with success. And thus, although Galvani is the reputed author and originator of this science, yet it is to an intelligent and observing lady that the world is doubtless indebted for the discovery of the powers of Galvanism.

GRAND RESULTS FROM TRIVIAL EVENTS.

In connection with this subject, it is worthy of remark, that, in the history of the rise and progress of some of the most important sciences, some very trivial circumstances or mere accident has been the prime cause of surprising results and developments. It is somewhere recorded, that Sir Isaac Newton was first led to those sublime investigations which overturned the old Ptolemaian system of philosophy, by a circumstance so simple as the fall of an apple, which suggested the subject of gravitation. The furious and forceful ebullition of a boiling tea kettle gave rise to a train of thought which resulted in the invention of the steam engine, and in the propulsion of steam boats and locomotives, and the same may be said of many other useful inventions. Not only was the science of Galvanism discovered by chance, but accident also led to the present arrangement of galvanic batteries.

ELECTRICAL EFFECTS UPON FROGS.

Upon metallic hooks, which were attached to the iron pallisades of Galvani's garden, frogs happened to be

hung up by the spine after they had been dressed, as in the former case, for food, (as frog soup in those days, and in those countries, was regarded as a very dainty dish, although our epicureans might wonder at their singular tastes.) Whenever, by the blowing of the wind, or by any other cause, the frogs were made to swing, so as to touch occasionally the pallisades, they were thrown into convulsions. The professor, who observed it, was, at first, quite puzzled to account for the phenomenon. He, however, imputed it to animal electricity.

VOLTA'S OPINION OF THOSE EFFECTS.

Professor Volta, of Pavia, objected to this conclusion, and affirmed that it must be the effect of the electricity produced by the contact of two metals, and that the muscles and nerves of the animal, were only the medium through which it was conducted, and that the convulsions were produced by the effect of that electricity upon those muscles and nerves. This conflict of opinion with opinion, and intellect with intellect, and the truths and facts which were elicited by the controversy, resulted at length in establishing the theory of Volta, that by forming a certain connection between different metals, electricity is produced.

SIMPLE GALVANIC ARRANGEMENTS.

The simplest galvanic arrangement is that in which a piece of zinc is placed beneath the tongue, and a piece of copper above it. Then, whenever the edge of

the two metals, thus situated, is brought in contact, there will, whether the eyes be opened or closed, be perceived a slight flash of galvanic light. This flash will be produced as often as the metals are separated and brought in contact again.

By putting a strip of zinc and one of copper into a tumbler of acidulated water, and bringing the two in contact at the top, galvanic effects are produced ; or, if they be set upright in the glass, and separate from each other, and in that position be connected by means of two wires soldered to the two plates, which wires are called poles, the same galvanic effects are produced.

The effects, which are produced by an arrangement so simple, are, however, imperceptible by any of the ordinary processes by which we ascertain the existence of a galvanic current. There will be perceived no sensible flash, if the circuit be broken and closed alternately, through mercury. No shock will be felt by the experimenter, as he forms a part of the circuit, nor will any effect be produced upon the muscles and nerves of animals.

GALVANOMETER.

There is, however, an article of apparatus, called a galvanometer, or galvanic Multiplier, which was invented by Schweiger, for the purpose of detecting and ascertaining very minute currents of galvanism, and

their strength or intensity. This instrument is composed, in the language of Turner, of a copper wire, "bent into a rectangular form, consisting of several coils, and in the centre of the rectangle is placed a delicately suspended needle. Each coil adds its influence to that of the others; and, as the current, in its progress along the wire, passes repeatedly above and below the needle in opposite directions, their joint action is the same. In order to prevent the electricity from passing laterally from one coil to another in contact with it, the wire should be covered with silk. The ends of the wire are left free for the purpose of communication with the opposite ends of a voltaic circle. When a single needle is employed in the experiment, its movements are influenced partly by the earth's magnetism, and partly by the electric current. The indications are much more delicate when the needle is rendered *astatic*, that is, when its directive property is destroyed by the proximity of another needle of equal magnetic intensity, fixed parallel to it, and in a reversed position, each needle having its north pole adjacent to the south pole of the other; in this state the needles, neutralizing each other, are unaffected by the magnetism of the earth, while they are still subject to the influence of galvanism. For researches of delicacy, the needles should be suspended by a slender long thread of glass, and the deflecting force measured, not by the length of the arc traversed by the needle, but by the torsion required to keep the needle at a



constant distance from the wire, as in the torsion electrometer of Coulomb.

The mutual influence of a magnetic pole and a conducting wire changes with the distance between them. Experiment shows that the action of a magnetic pole and a continuous conductor, every point of which exerts separate energy on the pole, varies inversely as the distance. This result justified the opinion, that the force of a magnetic pole on a *single* point of a conductor varies as the square of the distance, the same law which regulates the distribution of heat and light, as well as the effects due to electricity.

ONE METAL AND TWO LIQUIDS.

It is not absolutely necessary that there should be connected together two plates to produce a galvanic current. A simple voltaic circle may be formed by *one* metal and *two* liquids, so arranged, and possessing such different degrees of decomposing power, that one side of the metal shall be acted upon more intensely by the decomposing agent than the other. In order to test this, let a piece of zinc, for instance, be cemented into a box, so as to leave a cell on each side of the plate. Then, by putting a solution of salt into one cell, and nitric acid into the other, a positive current will run to the cell containing the solution of salt, if the liquid of the two cells be connected by means of a metallic conductor. And galvanic excitement can be produced even with *one* metal and *one* solution, p

sessing the same decomposing power, provided that the acid in one of the cells be warmer than that in the other ; in which case the warm acid will decompose the zinc more rapidly than the cold, and, of course, a current of positive electricity will set from the side of the plate affected by the warm acid, round to the side affected by the cold.

GALVANISM OPPOSED TO TWO FLUIDS.

From the facts developed by the above experiment, it must appear evident to every one, that galvanism affords no support to the theory of two fluids. There is evidently but one current, and that appears, as is abundantly shown by this apparatus, to depend upon a plus and a minus. The side affected by the warm acid decomposes the zinc the most rapidly, and is, therefore, plus with regard to the other side, which decomposes less rapidly. The current, of course, runs from the plus to the minus, in accordance with an immutable and universal law of nature. For what is that current—what, in fact, is galvanism, but the latent caloric of the metal set free by the combined action of its own powers and those of the acid? And why does the current run from the plus to the minus, if it be not in obedience to a law of caloric, which always seeks to restore and keep up an equilibrium in nature? It certainly must be in obedience to such a law, and we do not believe that any chemist can philosophically and rationally account for it in any other way. It must

be something which is set at liberty by the decomposition of the zinc, and the more rapid the decomposition, the greater the amount set free. If that agent, thus set free, be not latent caloric, it would puzzle a philosopher to define what it is.

COURSE OF THE CURRENT.

The current of a battery always runs from the electro-positive metal to the electro-negative, because the electro-positive metal is always rapidly decomposed by the action of the acid, while the electro-negative is scarcely affected at all. The latent caloric, being set free, obeys, therefore, the immutable law of free caloric, and runs from a plus to a minus, and that constitutes galvanism.

PROVES ONE FLUID.

If this be true, as it doubtless is, it annihilates the last vestige of support for the theory of two fluids, and proves to a demonstration that there is but one. So impressed was Turner with the fact that Galvanism furnishes no support for the doctrine of two fluids, that he seems to have abandoned it, in a measure, in his explanations of the passage of the galvanic current. He says, on page 88 of his Chemistry: "A current of negative electricity, agreeably to the theory of two electric fluids, ought to traverse the apparatus in a direction precisely reversed; but for the sake of sim-

plicity, I shall hereafter indicate the course of the positive current only.

THE GLASS SERIES.

A still more efficient arrangement, but yet a very simple one, it being one of the first inventions in the infancy of the science, consists of a series of glasses, or glass tumblers, connected with each other by a metallic arc, with a piece of zinc at one end and a piece of silver or copper at the other. These glasses are filled with some saline or acidulated solution, as salt water, or sulphuric acid, or diluted sulphate of copper, and the circuit is then closed by the experimenter, by putting the finger of one hand into the glass at one extremity, and those of the other into the glass at the other extremity. In this situation a person will receive a shock every time he replaces his fingers after removing them.

COATED GLASS.

Another very cheap and simple galvanic arrangement can be made by taking a number of pieces of common window glass, three or four inches square, and after coating them on one side with zinc foil, and on the other with copper or silver foil, by placing them upon each other, the two opposite metals always in contact, taking the precaution, however, when coating the glass, not to let the metals cover the entire surface.

Each additional plate of glass, thus coated, will increase the electric influence of such a pile, but yet, some thirty or forty must be so connected, in order to give any degree of intensity.

COATED PAPER.

Instead of using glass, which is a non-conductor, if we use discs of paper, which is an imperfect conductor, similar electrical phenomena will be produced, though somewhat more intense, with a given number of coatings of zinc and copper foil. To construct such an apparatus, the most convenient method is to cut the paper into round pieces about the size of a half-dollar, suitable for admission within a good sized glass tube, after having coated them on each side with zinc and copper foil, observing to have the coat of zinc always downwards and that of copper always upward, or that of copper always downward, and that of zinc always upward, which is immaterial. The tube should be long enough to hold one or two thousands of those discs, and the two ends be closed with some metallic plate in contact with the discs, provided with connecting wires or poles. The zinc end of such a pile is always positive, and the copper end always negative. And why? Because the current is always outward from the zinc, and inward to the copper, which shows that relatively, with regard to each other, the zinc is always charged plus, and the copper minus.

DRY COLUMNS.

Such an apparatus as we have described constitutes what has been called the dry column of Zamboni and De Luc, two of which the latter constructed, and having placed them near each other, so that the positive pole of the one would correspond with the negative of the other, he suspended between them an insulated bell, with an insulated bell on each side, which kept up a continual ringing for years, with only now and then a slight intermission. A light insulated needle properly arranged, and balanced upon a pivot, would oscillate continually between them.

CHAPTER X.

VOLTAIC PILE.

THE next improvement in the construction of galvanic apparatus, the one which Thompson remarks, "should be ranked among the greatest discoveries, from the enlargement which it has given to our knowledge of electricity, and its effects, and the extension and perfection of chemical science, is the Voltaic Pile, so called from Volta, Professor of Natural Philosophy at Pavia. If we compare the state of chemistry before the discovery of the Voltaic Pile, with its present aspect, we cannot but be astonished at the difference, and this difference is, in a great measure, owing to the discoveries made by means of this new instrument of investigation."

The improvement spoken of consisted in substituting plates of metal for the foil, or leaf, and wet instead of dry columns, which vastly increased its power. This pile consisted of alternate layers of circular plates of zinc and silver, or zinc and copper, with card or paste-board between them, moistened with some saline solution. To the two extremities of this pile, being in opposite states of electricity, conducting wires were attached. and when brought into contact, galvanic

phenomena were produced. The greater the number of alternate layers of such a pile the greater the electrical intensity, or, if it be desirable to construct a pile of this kind of considerable power, and it be inconvenient to form it in one pile, two may be used just as well, by connecting the positive pole of the one with the negative pole of the other.

ELECTRIC AND GALVANIC SPARK IDENTICAL.

The prominent leading object which we shall have in view in our experiments and deductions from them, will be to establish, beyond the possibility of a rational doubt, the identity of the imponderables. One of the illustrations, which will aid in the demonstration of that fact is the similarity between the galvanic and the electric spark. If we alternately break and close the circuit of the pile, as it is called, through the medium of a cup of mercury—that is, if we keep one pole constantly in the mercury, and alternately insert and remove the other, there will be an explosion of a brilliant spark consequent upon every removal, which every one can perceive is precisely similar to the electric spark.

WILL CHARGE THE LEYDEN JAR.

In proof of identity, there is another conclusive illustration. If we place the two poles of the pile in contact with the knob of a Leyden jar, and keep them in contact for some time, the jar will be charged the

same as with an electric machine, though its intensity will be somewhat lower. This fact can be shown by discharging it with an electric discharger.

WILL GIVE SHOCKS.

This pile will give out shocks like an electric machine. If a finger of each hand be first moistened with water or some acidulated solution, and be touched to the two poles of the pile, there will be perceived a shock more or less intense, in accordance with the number of plates in the arrangement. Just such a shock will be repeated every time the person trying the experiment shall make and break the connection, by removing and replacing one of his fingers. But if the finger be continued in contact, without making or breaking the connection, there will be no particular sensation produced or perceptible, unless there be somewhere on the hand a rupture of the skin, in which case there will be experienced a slight burning sensation.

There is another experiment, which will develop a very extraordinary and mysterious fact, respecting one of the inherent constituent properties of electricity, which we shall thoroughly investigate in this connection, and see, if it does not throw a flood of new light upon the phenomena of disease, the best methods of medical treatment in certain cases, and the hidden organic causes and laws of chemical changes—of de-

compositions and recompositions. The fact to which we shall allude is this.

KEY TO CHEMICAL CHANGES.

If a person shall touch the negative end of the Voltaic pile with a moistened finger, and bring a platinum or gold wire from the positive end in contact with the tongue, a strong acid taste will be perceptible in the mouth of the experimenter. But if the wire from the negative end be brought in contact with the tongue, while the moistened finger be placed in contact with the positive pole, there will, on the contrary, be produced in the mouth a strong burning or alkaline taste. Now why is this? The answer to this question might well of itself fill a volume, for it is a key to unlock the rich casket of a thousand mysteries.

IMPORTANT QUERY.

Why will the *positive* pole, when brought in contact with the tongue, produce an *acid* taste, and the *negative* pole an *alkaline* taste? We shall assume, in the first place, as the basis or data of our reasonings and deductions upon the subject, that it must be something *inherent* in the galvanic current itself, or in some chemical change produced in the system by the course of the passing current, or in both combined. We believe it to be in both combined.

THE AXIOM.

In our investigations of common electricity, it will be recollected that we established, upon the basis of a self-evident proposition, that one end of its ultimate particles is opposite entirely in its nature to the other end, since one end of a current is attractive and the other repulsive, and, as the laws of a whole are the laws of its parts, according to the axiom, then, of course, each atom of that whole has an attractive and a repulsive power, by the opposite polarity of its opposite ends. Now then, if, as is demonstrated in the experiment just referred to, the whole current has a taste, just in accordance with the direction in which it runs across the tongue, each ultimate particle, which aids in constituting that current and its organic laws, has also a taste in accordance with the direction in which it runs, as can be proven by the same process of reasoning.

THE LOGICAL DEDUCTION.

It is demonstrated, then, by experiment and by deductions built upon self-evident propositions, that each of the two ends of the ultimate particles of electricity have opposite tastes—the one an alkaline and the other an acid taste.

NATURE'S UNIFORMITY.

Now how admirably this fact exhibits the uniformity of nature's laws! How lucidly it proves

that there is no clashing at all in the principles of her government! What a firm and immovable basis it lays for confidence, that, when we have ascertained, beyond the possibility of doubt, one isolated fact, proving the existence of a certain definite law, other facts, when discovered, will harmonize with the evidence of the first fact, if they relate to the same subject or class of subjects, and will increase the weight of proof as to the existence of such a law, thus chaining the uniform testimony of isolated facts together into an harmonious and irresistibly convincing sum total of proof, and thus giving a satisfactory and almost mathematical certainty to our knowledge!

FACTS DEMONSTRATED.

What is the corroborating testimony of facts in the case under consideration? It is this. We have already demonstrated, by a series of deductions, based upon experiments, that the two ends of every ultimate particle of electricity have opposite polarities—that, when a body is charged plus, there is an emanation—that, in every emanation, or outward current, the ultimate particles of the agent that constitutes it present their positive end, as that always leads—that a minus body has an *inhalation* of the electric breeze, as it were, or an inward current from surrounding substances, and is negative, because the rear end of each particle, or that which always follows the lead of the

positive in all the movements of electricity, is, in its organic constitution, negative.

HARMONIZING FACTS.

Now, then, for a forcible illustration of the admirable uniformity of those facts, which demonstrate nature's laws. When a current of electricity runs *in* at the tongue it leaves an *acid* taste, and when *out* of the tongue an *alkaline* taste. Now the inward current, as we have before frequently remarked, presents its *negative* end and the outward its *positive* end. In the inward current, the negative end of each particle as it passes in gives inherent organic taste, and so with the other. Now, in what electrical states are the alkalies and the acids? Why, exactly in *opposite* states. The acids are negative and the alkalies are positive. The inward current has a *negative* polarity, and is also *acid*, and the outward has a *positive* polarity, and is *alkaline*. The positive and negative, then, in both cases—yea, in the whole three cases, agree perfectly, both as to *taste* and *polarity*—the taste of the negative end of a current being acid, which acid, in the form of salts, is also negative, and the taste of the positive end of a current being alkaline, which alkaline, in the form of salts, is also positive.

ATTRACTION OF ALKALI AND ACID

The strong chemical affinity which exists between the alkalies and the acids is familiar to all. Tartaric

acid and soda, for instance, when brought in contact with each other in solution, are attracted to each other, a powerful effervescence ensues, and a chemical union is formed between the two. Now this attraction must be entirely owing to the attraction of positive and negative electricity, or of opposite polarities, since the one is plus and the other minus, and since a foundation seems to be laid for an alkali and an acid in the organic constitution of the ultimate particles of electricity itself.

INFERENCES.

In the harmonizing facts which these experiments develop, we doubtless discover the very fundamental cause of all chemical attractions or affinities, and, of course, of all chemical changes, as well as the causes of disease and the most appropriate remedies for such disease.

After having given a further description of the progress of the science of Galvanism, in the construction, improvement and use of apparatus, we will then discuss in full the several topics of the chemical decomposition of substances, the various causes and phenomena of disease in the human system, so far as they depend upon the different electrical states of that system, and the appropriate remedies for such disease, and the chemical reasons why such remedies in certain cases are available.

CRUIKSHANKS' BATTERY.

The next invention which followed those to which we have alluded was that of the trough, or galvanic battery, by Mr. Cruikshanks, of Woolwich, England, which succeeded the Voltaic pile, and, with improvements, is now generally used. His trough consisted of baked mahogany, about four inches wide and four deep. Into grooves cut in the sides and bottom of this trough, at small distances from each other, were inserted alternate plates of zinc and copper, soldered together at the ends, and cemented into the grooves by sealing-wax, or some other similar material, so as to prevent the water from passing from one cell to another. Into these insulated cells was poured either a saline or a strongly acidulated solution, and the extreme plates were brought into connection by means of conducting wires, called poles.

This battery was very materially improved by so constructing it, that the zinc plates could be lifted out of the cells when not in use, and thus their otherwise rapid corrosion was, in a measure, prevented.

Following this are the improvements made by Dr. Hare, of Philadelphia, and which are thus described by Thompson.

DR. HARE'S CYLINDRICAL BATTERY.

"Dr. Hare, professor of chemistry at Philadelphia, has contrived a new modification of the galvanic apparatus. He takes two plates, one of copper and

the other of zinc, and placing a disc of leather between the two, he rolls them up in the form of a spiral. The leather disc is now removed, and the two metals are prevented from touching each other by interposing slips of wood. Each of these plates is made to communicate with a plate of a different kind of metal, the zinc with copper, and the copper with zinc, precisely in the way already described when giving an account of the troughs. A number of these double spirals are fixed upon a piece of wood in the same way as has been just explained. These cylinders are now introduced, each into a cylindrical glass vessel. This method of construction is attended with several important advantages. By this contrivance, plates of a very large size may be introduced into a small vessel; so that the expenditure of liquid is the least possible. Besides the greatest part of the two sides of each plate is active, being placed opposite to a face of the other metal.

HIS DEFLAGRATOR.

“Dr. Hare has constructed another apparatus which he calls a *deflagrator*, and which appears to possess very great power. He takes a plate of zinc three or four inches square, and closes it in a case of copper, distant from it about a line, and touching it nowhere. Any number of these plates thus inclosed in copper is attached to a horizontal piece of wood, and fixed immovably, that there may be no risk of the plate of zinc

touching the copper case in which it is enclosed. The zinc plate at the first of these is united at the top to the copper case of the next zinc plate. And this is continued through the whole. These copper cases are placed at a very small distance from each other, and between each pair is introduced a piece of card dipped in Linseed oil varnish, and half dry. They are then compressed so as to adhere so closely to each other, that no water can insinuate itself between them. Things being thus disposed, the apparatus is plunged into a trough containing the liquid, and not divided into cells; the varnished card answering all the purposes of the diaphragms in the porcelain troughs. Four such pieces of apparatus, containing each fifty plates of zinc, surrounded by its copper case, when plunged into the proper troughs, produce very powerful effects."

OERSTED'S APPARATUS.

"The apparatus employed by Oersted, and of the efficacy of which he speaks in high terms, approaches very nearly to this last one of Hare. Indeed the theoretical construction of both is the same."

We have not time to describe the various experiments and improvements of Morichini, Professor Oersted of Copenhagen, Sir Humphrey Davy, and several others. We would only remark, that it has been ascertained that an arrangement of a very large number of small plates constitutes the kind of battery to

be used in giving shocks and in chemical decompositions, and that an arrangement of a few plates, exposing a very large surface, constitutes the proper kind for evolving very great heat.



CHAPTER XI.

WONDERFUL EXPERIMENTS OF DR. URE.

Dr. Ure, of Glasgow, Scotland, performed, some time since, upon the body of a murderer, who had been hung, several experiments with a battery, consisting of 270 pairs of four inch plates.

1st. One pole of this battery was introduced into an incision in the nape of the neck, so as to come in contact with the spinal marrow, while the other was applied to what is called the sciatic nerve. The consequence was, that every muscle of the body was agitated with a convulsive quiver, as if violently shuddering from the effect of cold.

2d. By continuing one pole in the nape of the neck, as before, and removing the other to an incision made in the heel, the knee being previously bent, the leg was thrown out with such force and violence, as nearly to kick over one of the assistants, who attempted to prevent its extension.

3d. One pole was inserted in an incision made to what is called the phrenic nerve, and the other between the ribs, so as to touch the diaphragm at the bottom of the lungs. The consequence was that the chest rose and fell as in heavy natural breathing.

4th. One pole was brought in contact with the supra-orbital nerve, in the forehead, and the other with the heel, when every muscle of the countenance was simultaneously thrown into fearful action. Rage, horror, despair and ghastly smiles united their hideous expression in the murderer's countenance. So horrid was the sight that several spectators were forced to leave the room in which the experiments were made, either from terror or sickness, and one gentleman fainted.

5th. One pole was inserted again in the nape of the neck, and the other brought in contact with the ulner nerve at the elbow. Immediately the fingers moved nimbly, like those of a violin performer. An assistant tried to close the hand, but found it would open forcibly, in spite of his efforts. When the rod was removed from the elbow to a slight incision in the forefinger, the fist being previously clenched, that finger instantly extended, and, by the convulsive agitation of the arm, the murderer seemed to point to the different spectators, some of whom thought he had come to life.

Before we dismiss this subject, we wish the reader to keep in recollection those interesting and important experiments, as we think they will throw some light upon the subject, when we come to consider the agency of the electric principle in the various departments of organic life, and the abstruse science of Pathology.

CALORIMOTOR.

Before entering upon the discussion of the subject of the chemical changes produced by the imponderable principle in ponderable matter, whether organic or inorganic, we will give a description of one or two of the most important pieces of galvanic apparatus now in use.

Mr. Hare's Calorimotor, as it is called, is a battery of the other kind which involves great heat, and yet produces but a slight electric effect upon the muscular system and in the chemical decomposition of substances.

He constructed it of several 18 inch plates, and had it so arranged that all the plates of copper were connected together by a band of metal, and those of zinc in the same way. By this arrangement, all the plates acted in unison, in fact, but one pair, having an immense surface exposed to the galvanic action.

CHILDREN'S BATTERY.

Mr. Children, of England, in 1814 constructed one of this kind, consisting of 20 pairs of zinc and copper plates, each 6 feet long and 2 feet 6 inches broad, connected together with straps of lead. By immersing the battery in a mixture of nitric and sulphuric acids, diluted from 20 to 40 times their weight of water, the following experiments were made: A platinum wire, 1 foot six inches long, and 11-100 of an inch in diameter, was made red hot throughout, so that the incandescence was visible in full day light. Eight feet and

six inches of platinum wire, 44-100 of an inch in diameter, were heated red. A bar of platinum, 1-6 of an inch square and two inches and a quarter long, was heated red hot and melted at the end. A round bar of the same metal 276-1000 of an inch in diameter and two and a quarter inches long, was heated bright red throughout.

EFFECTS OF DIFFERENT SOLUTIONS.

Before passing to other topics, it may be appropriate, in connection with the subject of galvanic batteries, to remark upon the different solutions used in experimenting and their various effects. This we will do in the language of Thompson, page 517 :

“The energy of the galvanic battery depends very much upon the nature of the liquid employed as a conductor between the pairs of plates. The better conductor of electricity it is, the more powerful, *ceteris paribus*, is the energy of the battery. When we employ pure water the energy is a minimum. Indeed, it seems doubtful whether the pile possesses any activity when the water used is perfectly pure, and perfectly freed from atmospherical air. Water containing a salt in solution answers much better, because the addition of a salt increases very much the conducting power of water. Common salt, sulphate of soda, alum, nitre, or sal ammoniac, are often employed. The more easily the salt is decomposed the better does it answer. Acids, on that account, answer better than

salts. The three acids usually employed are the sulphuric, muriatic, and nitric. Of these the muriatic acid has the least energy; the sulphuric comes next in order, but the nitric acid is the most efficacious of all."

NITRIC ACID.

"The stronger the saline or acid solution is, the more powerful is the action of the battery. The action of nitric acid is the most energetic, but it ceases most speedily. The experiments of Gay-Lussac and Thénard have shown that the addition of 10, 20, 30, &c., parts of concentrated nitric acid to a given weight of water increases the intensity of the battery 10, 20, 30, &c., times, or that the energy is directly proportional to the strength of the acid employed. The charge usually employed in this country is a mixture of 1 part of concentrated acid with about 20 or 25 parts of water."

SULPHURIC AND MURIATIC ACID.

"The action of the sulphuric acid lasts longer than that of the nitric, and that of the muriatic is more lasting than that of the sulphuric. The addition of some sulphuric acid to the nitric acid solution (as was the practice of Sir H. Davy) renders the action much longer—because the sulphuric acid prevents the nitric acid from being saturated by the oxyd of zinc formed. The energy, of course, continues till the whole nitric acid is decomposed.

SAL-AMMONIAC.

“Of the salts, sal-ammoniac is the most powerful. A solution of common salt in vinegar acts well, and is most commonly used by experimenters, as the cheapest ingredient likely to answer the purpose.”

“Having given a sufficient account of the galvanic apparatus, it is time to turn our attention to the effects which it produces.”

CHAPTER XII.

OUR GENERAL PROPOSITION.

IN the second chapter of this work it will be recollected that we assumed that there were but *three* essential principles in creation, viz., *ponderable matter*, *imponderable matter*, and mind ; and that all the chemical changes, within the whole wide range of philosophic investigation, were produced by the energizing influence of the imponderable principle over ponderable matter. This, we are aware, is stating a proposition, somewhat new, in strong and decided terms—is taking a position which has not been definitely taken by any standard authors upon the subject, although they have published many things and facts, which will be of very essential service in aiding to establish fully what we are attempting to demonstrate ; and as many may very probably be disposed to regard the position as wholly untenable, we shall first quote largely from Thompson, to show what has been ascertained by experiment, as he seems to have taken much pains to collocate and condense the recorded results of the labors of learned and practical chemists.

EXPERIMENTS AND OPINIONS OF THE SCIENTIFIC.

Our first examinations will be confined to inorganic substances, and, as we quote the opinions of others, we shall regard them merely as opinions, disconnected entirely from the facts recorded, which opinions we shall not regard as resting upon an infallible basis of reasoning, nor shall we endorse their conclusions as resulting necessarily from the facts of the case, except where it shall appear perfectly conclusive that they do.

We shall also premise another thing before proceeding to make those quotations. They may not be exactly arranged in that methodical order and concise form, which would strictly comport with a work designed to be so condensed as this. The reader will, therefore, make all appropriate allowances.

We shall first quote what Thompson says, between pages 491 and 495, under the head of "*Electricity by Contact.*"

SIR HUMPHREY DAVY'S EXPERIMENTS.

"A considerable number of experiments on electricity by contact was made by Sir H. Davy. When oxalic, succinic, benzoic, or boracic acid, perfectly dry, either in powder or in crystals, are touched upon an extended surface with a plate of copper insulated by a glass handle, the *copper* becomes *positive*, and the *acids negative*. When zinc or tin is substituted for copper the effect is the same. Phosphoric acid, perfectly dry,

When applied to copper, becomes negative and the copper positive. When metallic plates are made to touch dry lime, strontian, barytes, or magnesia, these alkaline bodies become *positive*, the metal negative. With soda the effect is the same. Potash attracts moisture so rapidly that the experiment cannot be tried with it. When sulphur is applied to polished lead, or to any other metal, it becomes positive.*

DECOMPOSING POWER OF ELECTRICITY.

"It has been ascertained that electricity, when employed in the way described heretofore, and known by the name of the Voltaic battery, is capable of decomposing all compound bodies, and the decomposition takes place according to a particular law. When two platinum wires attached to the two poles of the battery are plunged into a vessel of water, the water is reduced into its elements, and the *oxygen* is always excited from the wire attached to the *positive* pole, while the hydrogen rises from the wire attached to the *negative* pole. When the wires are plunged into a strong solution of muriatic acid, the chlorine is accumulated round the positive wire, and the hydrogen round the negative. The law according to which *hydrobromic* and *hydriodic* acids are decomposed is the same. The bromine and iodine are attracted to the positive pole, while the hydrogen is attracted

* Phil. Trans. 1807, p. 84.

to the negative pole. When chloride of sodium and potassium is decomposed, the chlorine passes to the positive pole, while the sodium and potassium pass to the negative pole. Were a compound of sulphur and oxygen to be decomposed, the oxygen would attach itself to the positive pole. But with sulphuret of zinc or of iron the case would be different. The sulphur would collect round the positive pole, and the metal round the negative pole. When salts are decomposed the acid is attracted to the positive pole, and the base to the negative."

INFERENCES.

Let it be premised here, that with the following inferences of Thompson we perfectly agree, with the exception of that in which he concludes that oxygen is *negative* and hydrogen *positive*. We claim the reverse, and will give our reasons when we come to investigate that subject.

"Now as bodies are attracted by those in a different state of excitement from themselves, it follows that oxygen, chlorine, bromine, and iodine, and acids, would not be attracted to the positive pole, unless they themselves were in a negative state; nor would hydrocarbons and bases be attracted to the negative pole unless they were in a positive state. From this it has been concluded that bodies which have an attraction for each other are in opposite states of electricity, and that it is to these opposite states that their attraction

each other, and their union with each other, is owing. The current of electricity destroys their union by bringing them into the same electrical state. In consequence of this view, which is at least exceedingly ingenious and plausible, bodies have been divided into two sets, those which are negative, and those which are positive. The following table exhibits a list of the negative bodies beginning with those which possess the negative property in the highest degree, and terminating with those in which it is lowest.

LIST OF NEGATIVES.

Oxygen,	Molybdenum,
Chlorine,	Chromium,
Bromine,	Tungsten,
Iodine,	Boron,
Sulphur,	Carbon,
Phosphorus,	Antimony,
Selenium,	Tellurium,
Arsenic,	Columbium,
Titanium,	Silicon.

LIST OF POSITIVES.

“The following table exhibits a list of the positive bodies beginning with the one in which the property is weakest, and ending with the one in which it is strongest.”

Gold,	Uranium,
Platinum,	• Iron,

Palladium,	•	Cadmium,
Osmium,		Zinc,
Iridium,		Manganese,
Rhodium,		Alumnium,
Mercury,		Thorinum,
Silver,		Yttrium,
Copper,	•	Glucinum,
Nickel,		Magnesium,
Cobalt,		Calcium,
Bismuth,		Strontium,
Tin,		Barium,
Zirconium,		Lithium,
Lead,		Sodium,
Cerium,		Potassium,

CORROBORATION OF OUR POSITION.

We wish the reader to mark particularly the *dilemma* in which Thompson finds himself with regard to the positive qualities of hydrogen.

"It is not easy to decide," says he, "where hydrogen should be placed. Compared with oxygen, it is strongly positive. But it combines with the potassium, and must with respect to it be negative. The bodies nearest the head of the first list being most powerfully negative, have the greatest chemical affinity for each other. Bodies in the same list have but little affinity for each other, those towards the bottom of the first have but little affinity with those towards the top of the second list. However the bodies in the same list

are not destitute of affinity for each other. Thus sulphur combines readily with arsenic; because these two bodies assume different states with respect to each other. When we decompose sulphuret of arsenic, the sulphur is attracted to the positive pole, and the arsenic to the negative; showing that the former is in a negative state, and the latter in a positive. It is for this reason that almost all the substances constituting the first list, are capable of uniting with each other as well as with those of the second. Now it deserves attention, that when the bodies constituting the first list unite with each other, they constitute *acids* or substances which act the part of acids; when they combine with the substances constituting the second list, they constitute *bases* or substances which act the part of bases. All the acids are combinations of the negative bodies with each other, all the bases are compounds of the negative bodies with the positive. I have left out azote because it is not easy to say where it ought to stand; but it belongs undoubtedly to the class of negative bodies, and should stand probably before *sulphur*.

"Hydrogen we have purposely omitted. It constitutes *acids* by combining with the greater number of the negative bodies; but we are ignorant at present of any compound which it forms with any of the positive bodies, excepting with potassium, which according to the experiments of Gay-Lussac and Thenard, absorbs hydrogen gas and forms a compound. F

this combination has not succeeded in the hands of other experimenters."

ATMOSPHERICAL ELECTRICITY.

"Ever since the discovery of the identity of lightning and electricity, the attention of electricians has been turned to the accumulation of electricity in the atmosphere. And various causes for such an accumulation have been assigned. The opinion of Volta has been most commonly adopted. According to him, whenever a body changes its state, it becomes electric. Now, water is continually ascending into the atmosphere in the state of vapor, or falling from it in the state of rain. By these continual changes of state, which this fluid undergoes, Volta supposed that the accumulation of electricity in the atmosphere was chiefly produced. This opinion was verified by Lavoisier and Laplace. But when Saussure repeated the experiments, he was unable to obtain any satisfactory results.

POUILLET'S EXPERIMENTS.

M. Pouillet has recently examined the subject with much care, and has found that no sensible quantity of electricity is evolved when water changes its state, unless at the same time some chemical action more or less vigorous accompanies the change. But whenever two gaseous bodies unite with each other, or a gaseous body with a solid body, one of the uniting bodies always gives out positive electricity, and the other

negative electricity.* These experiments being of great importance, both for understanding the sources of atmospherical electricity, and for determining the kind of electricity possessed by those bodies which have a chemical affinity for each other, it will be worth while to state them somewhat particularly.

COMBUSTION OF CHARCOAL.

“When charcoal is burnt it sometimes gives out positive and sometimes negative electricity, and sometimes no electricity at all. This depends upon the way in which the combustion is conducted. To obtain constant results, M. Pouillet proceeded in the following manner. He took a piece of charcoal of such a diameter that it could receive the form of a cylinder whose bases were nearly plain. This piece of charcoal was placed vertically, two inches and a half or three inches below a plate of brass which rests upon one of the discs of the condenser. The charcoal communicated with the ground, and was lighted at its superior base, taking care that the fire did not reach the lateral surface. A current of carbonic acid rises and strikes against the plate, and in a few minutes the condenser is charged. The electricity which it receives from the carbonic acid gas is always *positive*. If the plate be allowed to communicate to the sides of the charcoal, or if it be inclined so that the carbonic acid formed

* Ann. de Chim. et Phys., xxxv, 401.

must slide up along the base of the charcoal, no sensible effect is obtained."

"To obtain the electricity which the charcoal itself takes by combustion, M. Pouillet placed its inferior end directly upon the disc of the condenser, and then lighted its superior base. In a few minutes the condenser was charged with negative electricity. From these experiments, we learn that when charcoal is burnt, it becomes charged with negative electricity, while the carbonic acid evolved is charged with positive electricity. Now the combustion of charcoal is the combination of it with oxygen, so as to constitute carbonic acid. According to Pouillet, during this combination, the oxygen gives out positive electricity, which is found in the carbonic acid gas, while the charcoal gives out negative electricity, which is found in the portion of the charcoal not yet burned. Now when the carbonic acid gas is again decomposed into its elements, the oxygen takes back positive electricity, and the carbon negative electricity. Is not this the reason why the oxygen gas is attracted towards the positive pole of the Voltaic battery, while the carbon is attracted to the negative pole?"

COMBUSTION OF HYDROGEN.

"The flame of hydrogen gave contradictory results with respect to its electricity, as had been the case also at first with charcoal. In the course of a few minutes it gave indications both of positive and nega-

tive electricity; very intense and very weak indications, and often it was impossible to obtain any indication at all. But these difficulties were at length overcome by M. Pouillet in the following manner."

"The hydrogen gas was made to flow out of a glass tube. The flame was vertical, having a breadth of four or five lines, and a height of about three inches. A coil of platinum wire was employed to conduct the electricity from the flame to the condenser. When this coil was so much larger than the flame as to enclose it, and to be distant from its external surface about four inches, signs of positive electricity made their appearance. These signs became more and more intense as the distance diminished. But when the coil became so small as to touch the flame, the electrical signs became weak and uncertain. Thus it appears that round the flame of hydrogen there is a sort of atmosphere at least four inches in thickness, which is always charged with positive electricity."

"If a very small coil of platinum wire be placed in the centre of the flame in such a manner that it is enveloped on all sides, and made to communicate with the condenser, that instrument becomes immediately charged with negative electricity. Thus it appears that the outside of the flame of hydrogen gas is always charged with positive electricity, and the inside with negative electricity. It follows from this, that there is a layer of the flame where the electricity is invisible. Accordingly, if we regulate the coil in such a

manner that it penetrates nearly one-half into the bright part of the flame, all electrical indications disappear."

INFERENCES.

"From these experiments, it appears that the electricity evolved during the combustion of hydrogen is quite similar to what appears during the combustion of charcoal. The oxygen before it enters into combination is charged with positive, and the hydrogen with negative electricity. Oxygen, then, must part with positive electricity when it combines with hydrogen, and hydrogen must part with negative electricity when it combines with oxygen."

"If instead of making the hydrogen gas flow out of a glass tube, we make it flow out by a tube of metal, which does not communicate with the ground, but only with the condenser, this metal tube, which touches the hydrogen but not the flame, always becomes charged with negative electricity. But, if it communicate with the ground, it loses the negative electricity which it had lately carried to the condenser, and the product of the combustion preserves an excess of positive electricity."

"If we examine at a height of a few inches above the vertical flame, we find both the electricities in the same quantity and not re-composed. For if we present a soldered plate of zinc and copper, the zinc plate attracts the negative, and the copper plate the

positive electricity. When we go to a distance sufficiently great above the vertical flame, the electric fluids can no longer be recognized, because they have combined and neutralized each other."

"Pouillet examined the flames of alcohol, ether, wax, oils, fat, and many vegetable bodies which presented the same phenomena as that of hydrogen. That is to say, that a zone of air surrounding the flame was electrified plus, while the interior of the flame was electrified minus. All these combustions exhibit examples of oxygen uniting with hydrogen and carbon. The oxygen gives out positive electricity, while the combustible body, whether hydrogen or carbon, or a compound of the two, gives out negative electricity."

EXPERIMENTS OF OTHERS.

"It has been ascertained by the experiments of Priestly, Ingenhousz, Sennebier, Saussure, &c., that plants while vegetating, act upon atmospherical air; sometimes forming a great quantity of carbonic acid, which disengages itself insensibly, and sometimes on the other hand gives out oxygen gas in a state of greater or less purity. Now it appears from the preceding experiments, that when carbonic acid is formed by combustion, it is electrified plus. This led M. Pouillet to suspect that the carbonic acid given out during the process of vegetation, would be in the same predicament. To determine this point, he made the following experiment.

ELECTRICITY BY GERMINATION.

“ Twelve glass capsules, about eight inches in diameter, were coated externally for two inches round the lips, with a film of lac varnish. They were arranged in two rows beside each other, either by placing them simply on a table of very dry wood, or by putting them on a table previously varnished by gum lac. They were filled with vegetable mould, and were made to communicate with each other by metallic wires which passed from the inside of one to the outside of the other, going over the edges of the capsules. Thus the insides of the twelve capsules, and the soil which they contained, formed only a single conducting body. One of these capsules was placed in communication with the upper plate of a conductor by means of a brass wire ; while at the same time the under was in communication with the ground. Things being in this situation, and the weather very dry, a quantity of corn was sown in the soil contained in the capsules, and the effects were watched. The laboratory was carefully shut, and neither fire, nor light, nor any electrified bodies were introduced into it.”

“ During the two first days the grains swelled, and the plumula issued out about the length of a line, but did not yet make its appearance above the surface of the earth. But on the third day the blade appeared above the surface, and began to incline to the window which was not provided with shutters. Consequently the carbonic acid gas, which disengages itself during

the germination of seeds, is charged with positive electricity, and is therefore precisely in the same state as the carbonic acid gas formed by combustion. This experiment was several times repeated with success. But the electricity cannot be recognized unless the weather be exceedingly dry, or unless we dry the apartment artificially by introducing substances which have the property of absorbing moisture.

"These capsules being insulated, and the air being very dry, and the soil so dry that it is an imperfect conductor, it is evident that the electricity would be retained. Accordingly when the condenser was brought into a natural state after one observation, and if it was then replaced for experiment only during one second, it was found to be charged with electricity."

INFERENCES.

"It is obvious enough that the gaseous fluids given out by plants during the process of vegetation, being charged with electricity, must contribute to furnish no inconsiderable portion of the electricity with which the atmosphere becomes loaded. No doubt the carbonic acid gas evolved from animals by respiration is also charged with positive electricity; though it would be somewhat difficult to determine the point by actually charging a condenser, in consequence of the moisture with which the expired air is always loaded." *

* The reader may consult with advantage an elaborate and most ingenious set of experiments by Sir H. Davy, to establish his own views, which are inconsistent with those of Pouillet, in Phil. Trans. 1826, p 398

CHAPTER XIII.

QUOTATIONS FROM THOMPSON CONTINUED.

OTHER important agencies of Galvanism are described by Thompson, commencing on the 529th page of his work on "Heat and Electricity," which we shall quote in full before proceeding to comment upon them, and to make them the data of certain deductions, which have a bearing upon the settlement of the question at issue.

CHEMICAL EFFECTS.

"The chemical effects of the Voltaic battery have been investigated with much sagacity, and have thrown a flood of light upon the nature of chemical combination. Every substance constituting the liquid conductor interposed between the pairs of plates undergoes decomposition, one of its constituents being attracted to the positive plate and the other to the negative. Suppose the liquid conductor to be *water* ; the *oxygen* is attracted to the positive or zinc plate, which it converts into an oxyd, while the other constituent, the *hydrogen* is attracted to the negative or copper plate. Hydrogen does not combine with copper. It, therefore, makes its escape from the face of the copper plate in the form of hydrogen gas. Wh

water is

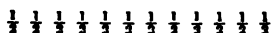
used, the decomposition is exceedingly slow, because pure water conducts electricity of low intensity very badly. If we add nitric acid to the water, the energy of the battery is very much increased, because the conducting power of the liquid is greatly augmented, and because the nitric acid undergoes decomposition much more easily than water. In this case both of the constituents of the liquid conductor undergo decomposition; the water is reduced into its elements as before, and the oxygen, as before, unites to the zinc plate, while the hydrogen is disengaged from the copper plate. The nitric acid is decomposed into oxygen and deutoxyd of azote. The oxygen unites to the zinc, while the deutoxyd of azote is disengaged in abundance from the copper plate. If the nitric acid solution used possess considerable strength, a good deal of heat is evolved, and the quantity of deutoxyd of azote and hydrogen given out is very annoying to the experimenter. The zinc is oxydized and dissolved very fast, and the energy of the battery is soon destroyed; because in a very short time the whole nitric acid is either decomposed or combined with the oxyd of zinc. The liquid becomes a solution of nitrate of zinc in water, which is, comparatively speaking, a bad conductor of electricity."

A FANCIFUL HYPOTHESIS.

To support a theory which we have abundantly shown to be absurdly unphilosophical, the learn-

author whom we are quoting certainly indulges here in fanciful speculations, unsubstantiated by fact; but we will continue our quotations, and dissect them afterwards:

"It would appear that while the energy of the Voltaic battery continues, two opposite currents of electricity pass through every stratum of liquid, interposed between every pair of plates. The negative electricity passes towards the copper plate and the positive electricity towards the zinc plate. To form a conception of the way in which these currents pass, let us consider the conducting liquid in its simplest state, or consisting of water. Water is a compound of oxygen and hydrogen. Let us consider only a single row of the particles of it, lying between the zinc and copper plate. Let fig. 1 represent oxygen, and fig. 2 hydrogen. A particle of water may be represented by the symbol $\frac{1}{2}$, and a row of particles of water may be represented thus—



"The current of negative electricity seems to pass along the particles of oxygen, and the current of positive electricity along the particles of hydrogen. From M. Pouillet's experiments, related in the last section, it would follow that when oxygen and hydrogen combine the former gives out positive and the latter negative electricity. We may conclude from this, that when they become charged again with their respective electricities they will separate from each other. The

particle of oxygen next the zinc plate, being thus disengaged from particles of hydrogen with which it was united, will be attracted to the zinc plate, give out its electricity to it, and combine with it. The same thing will happen to the particle of hydrogen nearest the copper plate. The electricity constantly passing along the row of particles, will occasion a succession of decompositions of the particles of water. But the hydrogen in each will instantly combine again with the next particle of oxygen in succession. It is not, then, the hydrogen which passes through the liquid from one plate to the other, but a rapid succession of decompositions, and as the first particle of water has parted with its oxygen, it is obvious that the last particle must part with its hydrogen."

"The same explanation applies to all the decompositions that take place in the liquid interposed between the respective pairs of zinc and copper plates. But it is usual to interpose between the two poles of the Voltaic battery a vessel containing the water or other substance to be decomposed. A platinum wire is made to pass into this liquid from each pole, and the series of decompositions may thus be observed."

NATURE OF THESE DECOMPOSITIONS.

"The nature of these decompositions was first investigated by Berzelius and Hisinger in a paper published by them in Gehlen's Journal for 1802.*

* Vol. i., p. 115.

They showed that a number of salts which they dissolved in water, and placed in contact with the two poles of a galvanic pile, by means of iron or silver wires, were decomposed, the acid being deposited round the positive wires and the base round the negative pole.* Ammonia was also decomposed; azotic gas separating from the positive pole of the battery, and hydrogen gas from the negative pole. When lime water was tried, no decomposition of the lime took place."

SOME CHEMICAL AGENCIES.

"In the philosophical transactions for 1807, an admirable paper was published by Sir Humphrey Davy, entitled, *On Some Chemical Agencies of Electricity*, containing a very minute and complete investigation of the chemical decompositions produced by Voltaic electricity. To perceive the full value of this paper, it would be requisite to have an idea of the previous state of our knowledge of this intricate subject. It had been already observed that when two platinum wires, from the two poles of a galvanic pile, were plunged each into a vessel of water, and the two vessels united by means of wet asbestos, or any other

* The salts tried were—

Sulphate of ammonia,
Nitrate of ammonia,
Muriate of ammonia,
Phosphate of ammonia,
Borate of ammonia,

Prussiate of ammonia,
Common salt,
Nitrate of potash,
Bisulphate of potash,
Sulphate of potash,

Muriate of lime.

conducting substance, an acid appeared round the positive wire, and an alkali round the negative wire."

DAVY'S DEMONSTRATIONS.

"This alkali was said by some to be ammonia, by others to be soda. The acid was variously stated as muriatic acid, nitric acid, or even *chlorine*. And it was generally admitted that these acids and alkalies were generated by the galvanic action. Sir H. Davy demonstrated, by decisive experiments, that in these cases the acid and alkali were derived from the decomposition of some salt contained either in the water or in the vessel in which the water was placed. Most commonly the salt decomposed was common salt; and he showed that agate, basalt, and various other stony bodies, which he used as vessels, contained quantities of common salt, appreciable by the galvanic action. When the same agate cup was used in successive experiments, the quantity of acid and alkali evolved diminished each time, and at last no appreciable quantity could be perceived. When glass vessels were used, soda was disengaged at the expense of the glass, which was sensibly corroded. When the water into which the wires were dipped was perfectly pure, and when the vessel containing it was free from every trace of saline matter, no acid or alkali made its appearance, and nothing was evolved except the two constituents of water, namely, oxygen and hydrogen,

the oxygen appearing round the positive wire and hydrogen round the negative wire."

DECOMPOSITION OF SALTS.

"When a salt was put into a vessel, into which the positive wire dipt, the vessel into which the negative wire dipt being filled with pure water, and the two vessels being united by a slip of asbestos moistened with water, the acid of the salt made its appearance round the positive wire and the alkali round the negative wire, before it could be detected in the intermediate space. But if an intermediate vessel, containing a substance for which the alkali has a strong affinity be placed between these two vessels, the whole being united by slips of asbestos, then a great part of, or even the whole of the alkali was retained in that intermediate vessel. When the salt was nitrate of barytes, and sulphuric acid was placed in the intermediate vessel, much sulphate of barytes was deposited in the intermediate vessel, and very little or even no barytes made its appearance round the negative wire. Upon this subject a most minute, extensive and satisfactory series of experiments was made by Davy, having no doubt whatever respecting the accuracy of the general fact. Indeed this paper of Sir H. Davy constitutes one of the most important contributions ever made to scientific chemistry, and threw a ray of light upon the chemical affinity, which may ultimately produce the most important consequences."

VERY IMPORTANT CONCLUSIONS.

The conclusions drawn by Davy from his experiments are, that all substances which have a chemical affinity for each other are in opposite states of electricity, and that the degree of affinity is proportional to the intensity of these opposite states. When such a compound body is placed in contact with the two poles of a galvanic battery, the positive pole attracts that constituent which is negative, and repels the positive. The negative pole acts in the opposite way, attracting the positive constituent, and repelling the negative. The more powerful the battery, the greater is the force of these attractions and repulsions. We may, therefore, merely by increasing the energy of the battery sufficiently, enable it to decompose any compound whatever. Oxygen, chlorine, bromine, iodine and acids, being negative bodies are attracted to the positive pole; while hydrogen, alkalies, earths, oxides, metals, and bases of all kinds, being positive, are attracted to the negative pole.*

* If this view of the subject, which is probably more conformable to truth than the view of Pouillet, given in page 497 of this work, be admitted, it will be necessary to modify the explanation of the way in which the electrical currents pass, given in page 531. If oxygen be negative, and hydrogen positive, it is obvious that the positive current will be attracted to the oxygen, and must pass through the hydrogen. These currents, by neutralizing the electricity in both bodies, will occasion the separation of the oxygen and hydrogen, and produce the decompositions referred to in page 531.

Such are the electrical, and such the chemical phenomena produced by the Voltaic battery.

OUR MOTIVES.

Our interesting quotations from Thompson's large work on Electricity have been quite extended, not because we by any means agree with all the *conclusions* he draws, but because he has condensed into one view a multitude of important *facts*, showing conclusively that electricity has something to do with all chemical decompositions and recompositions of matter. In our next, and some succeeding chapters, we shall rigidly examine his conclusions, and endeavor to show that they are partly true and partly false, from the facts which he himself has, with much labor, furnished, and shall make those facts, thus furnished, subservient to the purposes for which this work is published.

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CHAPTER XIV.

APPLICATION OF FACTS.

THE present, and some succeeding chapters, will be devoted to the application of those facts and principles of galvanism, which have been ascertained by our own observations, and those of others, to the further demonstration of the peculiarities of the theory we have assumed.

REASONS FOR EXTENSIVE QUOTATIONS.

Upon the subject of the intimate connection which exists between electricity, and the chemical changes which are wrought in various substances, we quoted largely, in former chapters—not because we could not have given those ideas in our own language, and thus have appeared to have written original thoughts—but because we wished to insert the *facts* collocated by an author so eminent as Thompson, the "*Regius Professor of Chemistry in the University of Glasgow*," Scotland, in his own language, so that, for minds, that demand the authority of great names, we might have a convenient reference in the body of this work; reserving to ourself, however, at the same time, the privilege which we shall ever claim and exercise, of drawing

our conclusions from those facts furnished, as the data of our reasonings.

UNIVERSAL LABORATORY.

The visible and probably invisible universe is nothing more nor less than one vast laboratory, in which chemical changes are continually progressing in an infinite variety of forms and modifications. The green mantle of vegetation, which clothes the earth in its beautiful summer vestments, receives its freshness, color, nourishment and exercise from the light, the caloric, the air, and the alimentary substances of the soil at its root, by means of a chemical change.

The tree of the forest first germinates, next becomes a little delicate twig, further on in its progress a pliant sapling, then it shoots upward with luxuriant, spreading branches, and downward with a firmer and deeper root, and becomes, at length, a stately monarch of the woodland, stubborn and unyielding to the wintry blast. All this progression is effected solely by a chemical change, which transforms the nutriment of the air and soil into wood.

Even the solid rock has its infancy, its manhood, and its old age. It begins to grow, increases in solidification and cohesive power, comes to maturity, decays, and crumbles again to a substance, possessing no power of cohesive attraction at all. All this too is effected by the potent agency of a continued chemical change.

ELECTRICITY THE CAUSE.

Now we assume that it is a proposition capable of rational, abundant, and satisfactory proof, that every one of these chemical changes is wrought by the resistless influences of electricity, or the light and caloric of the sun, as it falls upon, and pervades the whole material of the earth, for this light and caloric of the sun is the same thing, in fact, as electricity, which we hope abundantly to demonstrate in its proper place.

SELF-EVIDENT PROPOSITIONS RELIABLE.

That reasoning or superstructure of argumentation, which is built upon the immovable basis of self-evident propositions, cannot be overthrown by counter argumentation. It is perfectly impregnable. It is founded in the inherent nature and fitness of things which change not, while all else in creation changes.

OUR THEORY BUILT ON THEM.

Upon just such propositions we intend to build the superstructure of our argument, in proof of the assumed position, that all the chemical changes are wrought by the direct agency of electricity.

UNIFORMITY OF NATURE'S LAWS.

The laws which govern nature are uniform. There is no clashing among them. Were there any, the uni-



verse of material systems would exhibit one terrific scene of uproar, confusion, anarchy and chaos. The proposition that "*like causes produce like effects*" is self-evident. It cannot be made any plainer to a sane mind by any process of reasoning.

CHAPTER XV.

RECAPITULATION.

WE will now condense, into as brief a space as is consistent with a lucid perspicuity, the substance of the quotations we have made, correct what is erroneous, and then make such deductions and draw such conclusions as the undeniable facts in the case will warrant. This is the substance.

Bodies in opposite *chemical* states—that is—bodies which have a strong affinity for each other, are in opposite *electrical* states—the elements of all bodies or substances, which can be decomposed by electricity are either positive or negative — evaporation does not evolve electricity — it is, however, produced by the combustion of charcoal, hydrogen gas, and other bodies, and also by vegetation.

The constituent principles of bodies go to the different poles of a galvanic battery, and, by the influence of the electric agent, water is separated into its elements of oxygen and hydrogen gas, the first of which is negative and the last is positive.

WHEREIN CORRECT.

This is the substance, in brief, of those quotations. With the first fact, which they develop, we agree

perfectly. The acids are all *negative* and the alkalies are all *positive*. When brought in contact in the form of solution, a chemical union takes place, by the force of the affinity or the chemical attraction, which exists between the two substances. That affinity or chemical attraction, which brings the two bodies together, and effects their union into a new compound, depends entirely upon the electrical condition of the ingredients which compose them. The alkali is plus or positive, because, as we have before shown, it is surcharged with more than a natural share of electricity. That electricity is arranged therefore with the positive polarity of its ultimate particles outward, as in all surcharged bodies, which emanation outward, as we have demonstrated by the test of infallible experiment, constitutes it an alkali, and gives it an alkaline taste. The acid is minus or negative, owing to its destitution of electricity, which destitution gives, as we have elsewhere abundantly shown, a different arrangement to the ultimate particles of the electric agent, by which arrangement, as in all minus or negative bodies, the negative polarity is presented, which constitutes any substance an acid or gives it its acid taste.

NOT FANCIFUL

Let no one suppose that this is a mere fanciful hypothesis ; for we have already demonstrated, that the change depends upon an *inherent organic law* of electricity, by an experiment with the galvanic bat-

tery, by which it is shown, that if a current be *in* at the tongue and *out* of the finger, where one pole is brought in contact with the one, and the other with the other, it has an acid taste, and if in at the finger and out of the tongue, a strong alkaline taste, proving beyond contradiction, that an acid and an alkaline taste depend upon the electrical condition, instead of the condition of inert matter merely, without regard to its electrical state.

IMPORTANT QUERY.

This suggests the thought, which philosophers would do well to investigate, whether all tastes, and every shade of taste in ponderable substances, do not depend upon the different modification, or rather the different proportions of the admixture of these two fundamental and essential tastes, rather than upon any inherent organic quality in mere inert matter itself. Reasoning from the admirable uniformity of nature's laws, but without having time, in connection with this work, to demonstrate it, we should draw the confident conclusion that it did. If electricity constitutes an alkaline and an acid taste, *why* not, with the same propriety, the sweet, the bitter and every other possible shade of taste simply by the different electric states of bodies? That it does, we believe could be demonstrated by deductions based upon the self-evident proposition, "that like causes produce like effects," and if electricity produce taste in *one* case, it may in all cases.

A MESMERIC FACT.

A person, who has been mesmerized can be made to taste alkali or acid, sweet or sour, or indeed any other taste which the mesmerizer wills. And why? Because his system is controlled by the animal electricity of the mesmerizer, and that electricity produces such *taste* as he wills.

NO MISTAKE.

There cannot be any mistake about the electric states of the alkalies and the acids. The testimony of experiment is uniform. The one is always plus and the other minus, and the degrees of their plus and minus depend upon their concentration. Being plus and minus, they unite when brought together. That union exhibits force and is attended with the violent commotion of a rapid effervescence, as is familiar to all, in the union of tartaric acid and soda.

CAUSE OF THE AFFINITY.

Now what is that principle of affinity which causes the tartaric acid and soda to unite? Is it any thing inherent in the mere particles of inert matter themselves, which constitute the soda and tartaric acid? We think not. Upon conclusions drawn legitimately from all analogy we predicate this opinion.

Let us examine mere ponderable matter as critically and minutely as we may, and the conviction will be forcibly impressed upon the mind, that it has no such inhe-

rent energy—no such self-moving power as to produce a commotion among the ultimate particles of which it is composed so violent as that which occurs, when they unite with each other during effervescence. What then is that principle of affinity which brings them together, if it be not some inherent power belonging to the particles themselves? It is, without doubt, electricity, for it seems to have a sort of mysterious, indefinable, but yet positive ability to take hold of the particles of ponderable matter, as it were with a tenacious grasp, and, by its own unaided energy, control their movements. We see not how else they are brought into union. But if this be the controlling agent, which effects the work, then the process by which the union is accomplished is perfectly plain. There is no incomprehensibility about it, except what exists in the essential nature and qualities of the wondrous agent itself.

The one substance is surcharged, because positive, and the other deficient, because negative. There is then, upon principles, which have been already abundantly explained, an attraction between the opposite polarities of the electric principle, by which a plus and a minus are drawn together. Having, as we have before remarked, a hold, by some mysterious organic law of its essential constitution, beyond the ken of chemical analysis or investigation, upon the particles of ponderable matter, they are attracted along with it, and are thus brought, as we have seen, into a chemical union, and a chemical change is produced.

This chemical union and change is nothing more nor less than the simple equalization of a plus and a minus in substances, and by that equalization, a single compound substance is formed, very different in the properties of its combination from either of the two out of which it was formed. And why? Simply because it is in a different electrical state. This simple compound, we say is very different from the two out of which it was formed, in all the properties of its combination, for this is abundantly proven by the fact that a virulent poison may be made harmless by a chemical union, and harmless substances be also made virulent poisons by the same chemical union or chemical change.

This is done, in all cases, by simply changing their electrical state, which state can be varied by an almost infinite variety of shades and modifications, constituting color, tastes, motion, poisons, antidotes against poisons, and every other property and quality, which is manifested in matter, except its bulk, ponderosity and inherent inertness.

THE TRUE THEORY.

Upon deductions built upon fact and experiment, we believe this to be the *true theory* of all chemical changes in matter. Those changes are effected through the sole agency of electricity. The "*modus operandi*" of such changes may, it is true, be, in a measure, hidden sometimes from the inspection of the most acute, and may not, in a vast multitude of instances, be perfectly

apparent; but still abstruseness does not at all affect the reality of that agency.

If it can be proven beyond controversy and beyond the shadow of a reasonable doubt, as it certainly can, that such changes have been effected by such agencies, then it is logical to draw an inference from that self-evident proposition, that "like causes produce like effects," that *other* changes, whose cause is more obscure from certain circumstances that may surround them, are produced by the same agencies, in accordance with the same laws.

SIR HUMPHREY DAVY'S CONCLUSIONS.

In the quotations which we have made in a former chapter it will be recollected that Sir Humphrey Davy drew the conclusion, from a great variety of experiments, conducted with the utmost care, that *all* substances which have a chemical affinity for each other are uniformly in opposite states of electricity, and that the *degree* of affinity is exactly proportional to the *intensity* of those opposite states.

APPROPRIATE INFERENCE.

Now, if *all* substances, according to the test of Sir Humphrey Davy's experiments, which have a chemical affinity are in opposite electrical states, is not the union, which is effected by means of that affinity, effected simply, as we have shown, by the attractions of a positive and negative, since the laws of nature are

uniform, and since "like causes produce like effects?" or, in other words, that that chemical affinity which exists between all substances which will unite is nothing more nor less than electrical attraction.

SOLUTION AND PROOF.

There are two ways in which mathematicians prove the truth of their calculations to a demonstrative certainty. The one is by a direct and the other is by an inverse process of deduction. In the first, by a certain process of calculation or reasoning, they arrive at a certain result, and, in the other, by taking that result for their premises, and, by reasoning or calculating backward, they determine whether that process of deduction, by which they arrive at that result, is, every step of it, correct. By just such a plan of procedure can we determine the correctness of our previous chain of argument, respecting the phenomena of chemical union. We have, by a process of direct reasoning from cause to effect, come to certain conclusions. We will now, by an inverse process of argumentation from effect to cause, prove whether there be any flaws or broken links in that chain. We have demonstrated, by an allusion to facts with which all are perfectly familiar, that the alkalies and the acids will unite by the influence of chemical attraction or of electrical attraction, which is the same thing. Now, if we can show that these can be separated again, particle from particle, by the same agent that produces

their union, then we, by inverse reasoning from effect to cause, prove, beyond the possibility of mistake, that electricity is the efficient agent in the production of all chemical changes. And this has already been shown in the record of certain experiments, contained in the quotations of the previous chapter.

EXPERIMENTS OF BERZELIUS AND HISINGER.

It will be recollected by those who read the former chapter carefully, that, by the experiments of Berzelius and Hisinger, with a galvanic battery, as described by them in 1802, in Gehlen's Journal, various salts in solution were separated or decomposed, and the acid of the solution was deposited around the positive pole and the base or alkali around the negative pole, in accordance with an immutable chemical law of the attraction of unlike polarities.

INVESTIGATIONS OF DAVY.

The experiments of Sir Humphrey Davy abundantly confirm those of Berzelius and Hisinger. He found that, by increasing the energy of his battery sufficiently, and with appropriate apparatus for the purpose, he could decompose any compound body whatever, the negatives in all cases collecting around the positive pole and the positives around the negative pole, thus proving that the electric agent will separate compounds as well as form them, which we have heretofore proved.

OBJECTIONS ANTICIPATED.

A question may here arise, as to the correctness of our theory upon the subject of ponderable matter. We have assumed that it is a simple, essential principle, and that all its infinite variety of modifications of every kind are caused alone by the imponderable principle, which controls and arranges all its particles as we find them arranged.

Now this may be denied from the fact, developed by the experiments of the before-mentioned chemists, that one ingredient of a compound in solution goes to one pole of a galvanic battery, and the other to the other pole. It may, from this fact, and with great seeming plausibility be argued that the two ingredients which go to opposite poles, called alkalies and acids, must be matter inherently different from each other, and that, on account of that inherent difference, the separation takes place.

OBJECTIONS ANSWERED.

Such an inference, however, does not necessarily result from the premises. It can, in fact, be shown to be erroneous. They are not separated into constituent ingredients by any repulsive force, which exists within them inherently; because, if such repulsive *inherent* force *did* actually exist, the acids and the alkalies would not, under any circumstances, exhibit an attractive affinity at all, but would forever, and under every possible variety of conditions, exhibit the same stub-

born repulsive power, and, therefore, never amalgamate, as they do, when a new compound is formed, by the effervescence of tartaric acid and soda.

UNAVOIDABLE CONCLUSION.

This fact, that repulsion takes place under one set of circumstances, and attraction under another, speaks volumes in favor of the validity and truth of the proposition, that the alkalies and acids are united as in solution, and separated again, as in the galvanic experiment, *entirely* in both cases, by the force of electricity, exerted over their particles. This must, in reality, amount to a demonstration, in the view of every mind acutely logical.

PROPOSITION OF AN INQUIRER.

"But," says the inquirer after true science, "there must be something *inherently* different in the nature of the particles of the alkalies and the acids themselves, or else the positive pole of the battery would not attract the acid, nor the negative the alkali, but they would move indiscriminately either way, and not be decomposed at all."

PROPOSITION UNFOUNDED.

This assertion, however, is predicated upon the supposition that a particle, that was alkaline before being compounded by a chemical union, is also alkaline when separated by the energy of the galvanic battery.

But, at the risk of differing with the whole body of chemists, we shall affirm, that this by no means follows as a necessary consequence. It certainly can, with great plausibility, at least, be made a question, whether particles may not move indiscriminately to *either* pole without being influenced by quality, and *there*, by the peculiar influences which we know the two opposite poles of a galvanic battery exert over substances in contact with them, and which are confessedly very mysterious, be made either alkaline or acid by that contact.

PREJUDICE WILL OPPOSE THIS THEORY.

This supposition we know would do violence to the prejudices and prepossessions of many scholars. But why should it? Does not electricity evidently demonstrate, that, within *its own inherent organic nature*, is laid *alone* the basis of the alkalies and the acids, by the experiment upon the tongue with the inward and the outward current of a galvanic battery? This will not be denied, and cannot be, for "facts are stubborn things," which cannot be gainsayed nor resisted. Are they not, also, as we have abundantly shown, both decomposed and re-composed, and therefore, controlled by the electric agent, which would not, and could not be the case, if the two apparently opposite ingredients, which form the compound, were inherently different in their own organic nature, independent of the influence of imponderable matter? Most certainly.

For they would never thus separate and unite again, did the *force* which controls these opposing movements *reside within themselves*.

GEOLOGICAL AND CHEMICAL TESTIMONY.

Besides, its a fact revealed by both the researches of geology, and the experiments of chemistry, that the very same substance or mass of substances, yea, the very identical ultimate particles of a substance, may change their nature from age to age, by chemical processes wrought upon them.

Geology proves that such transformations have been occurring in all ages, and that they are continually occurring at the present time. And lest it should be said, for the purpose of weakening or attempting to invalidate our argument, that such transformations are never made of a substance, except the new formation be of the same nature as the old one, out of which the new was organized, and that a combustible furnishes the material for a new combustible formation, as wood and other vegetable matter, for instance, form bituminous coal, we would reply that such an assumption, is proven *false entirely*, by a multitude of conclusive facts.

TRANSFORMATIONS.

A substance, for instance, may have been animated flesh and bones, as in the mighty army of Xerxes, when he invaded Greece. That army, having been

mowed down upon the battle-field by the victorious invaded, may have mingled with the soil, upon which they fell, and, by their putrid blood, and flesh, and crumbling bones, have made the soil luxuriant. Out of it may have shot up a forest upon the desolated waste, and this flesh and blood and bones been re-formed into a grove of stately trees. These trees, in the revolutions of time, may have been swept away and buried by a deluge. There, within the bosom of the earth, they may have undergone another change, and have been re-formed either into solid rock, or beds of bituminous coal, to become the subjects of still further and equally remarkable transformations, being burned, and resolved into vapors, gases, ashes, and electricity, and prepared to enter in this state into the composition of an almost endless variety of other substances. This supposition, which we have made for the sake of illustration, is no fanciful chimera of the brain, but well-authenticated reality.

THE HONE.

Cut a billet of wood out of a green oak log, a foot long, three inches wide, and an inch thick; let it be taken partly out of the light-colored sap and dark-colored heart, so that there shall be half of each. Put this billet of wood, thus prepared, into the waters of a certain lake in Ireland; let it remain there undisturbed for SEVEN years, and it will become a *perfect stone* of the finest quality, called by some "*the hone*,"

such as is used for the best oil stones, or for sharpening razors.

In its transformed condition, it will retain the color of the sap and heart; will be about the same as to weight; the seams and woody fibres will be visible in perfect distinctness, and even any mark of the axe or hatchet that was used in hewing it; and yet its woody nature is *all gone*. Not a single quality of it remains, except the appearance of wood; for it is entirely *incombustible*. Its very nature is changed.

The size and form and proportions of the sap are not material. We merely specified that size and quality, because we *had seen* a petrified "hone" answering exactly to that description. Nor is it necessary that the wood should be oak. Any other wood and *any size* would be petrified as well.

PETRIFIED FOREST.

About ten miles from Cairo, in Egypt, scattered over a large extent of sandy plain, laying partly above the surface and partly covered with sand, is an immense forest, prostrated apparently years ago by some mighty wind or deluge, but retaining still the limbs and trunks of that forest.

At first glance the beholder would conclude that it was wood; but, upon striking it, he is surprised to find it solid, and to hear it ring like cast-iron. Instead of wood, it is *perfect silex or flint*.

It seems, according to the investigations of a geolo-

gist, reported for *Chambers' Edinburgh Journal*, to have, in the process of time, by the chemical mutation, undergone *two* transformations; first, from wood to carbonaceous coal, which is *combustible*; second, from carbonaceous coal to silex, which is perfectly *incombustible*.

PETRIFACTIONS IN PENNSYLVANIA.

From the authority of an unimpeachable eye-witness, there is, in a locality near Cannonsburg, Washington County, Pennsylvania, a zig-zag Virginia fence, or *worm fence* as it is sometimes called, the bottom of which is composed of logs. The fence has been built, perhaps, forty or fifty years, though of that we are not certain.

These bottom logs have, in some places, since cut from the forest and placed there, become perfectly petrified. Limbs broken from the trees, and laying on the *surface of the ground* in the forests in that locality, have in large numbers become also petrified by the peculiar chemical influences that prevail there.

BEECH LEAVES PETRIFIED.

We once had in our possession, from a locality near Akron, Ohio, a very beautiful and interesting petrification of *beech leaves*. It seemed like a mass of leaves matted together, when wet, which mass had become perfect stone, and yet, so complete was the form of the leaf in the petrification, that one could tell which was

the original upper side and which the under side ; the former being smooth, and the latter rough, like the leaf, with every rib and fibre distinctly perceptible.

MOSS AGATE.

We have seen agates wrought and perfectly transparent, in which could be seen completely developed to the nicest outline of its tiniest leaf and stem, a sprig of moss as brightly and freshly green, as when growing, and yet it had become *perfect transparent agate*.


ATTEMPTED SOLUTION.

Many, who oppose our theory, have said that the original substances are all conveyed away by a continued chemical change, and other substances brought back to fill their places. All the answer we have to make to such is, that men will sometimes adopt the *wildest and most absurd notions to keep hourly-headed error in countenance*.

We might extend our remarks upon the subject of the chemical changes of the character spoken of, until they should fill volumes, for they are almost infinite in variety. But sufficient has been already said to prove to a demonstration from the data of incontrovertible facts, that the forces by which chemical changes are wrought in ponderable matter, do not reside inherently in the substances themselves, or belong to their organic nature : for if they did thus reside, we hold it to be a proposition capable of the clearest and most

logical demonstration, that no such transformation of substances could ever possibly occur, but there would, then, be one changeless, unvaried scene, where now all is variety and ceaseless mutation.

We now leave this branch of our subject, with the feeling, however, that much more might be said, had we time and space, and that what we have said might have been vastly more appropriate, had we the ability of some, to whose attainments we presume not to aspire. In a subject as abstruse as that of the principle of chemical affinities, it must be expected that very many things will be passed over, without being made perfectly plain, and intelligible to all. Our object has been mainly to seize upon strong positions of lucid proof, where there could be no mistake or deception in our reasonings, or evasion of their propriety by others, and then from such strong positions draw reasonable and logical inferences respecting subjects more abstruse and difficult.



CHAPTER XVI.

OXYGEN AND HYDROGEN.

THE electrical condition of oxygen and hydrogen gas, and more particularly of oxygen, we shall now consider minutely, because it is, as we shall show, the most essential agent in chemical changes that exists.

There are, in the quotations which we made in some previous chapter, two clashing theories respecting the relative electrical state of those two gases.

POUILLET'S DISCOVERIES.

M. Pouillet, a distinguished chemist, by a variety of experiments, very carefully conducted, as we have seen in the quotations of the last chapter, came to the conclusion, that oxygen gas was positive and hydrogen negative.

DAVY'S CONCLUSIONS.

Sir Hunphrey Davy, on the contrary, from the test of experiment, came to the conclusion, in the same quotations, that oxygen is negative and hydrogen positive.

THOMPSON'S OPINION.

With this opinion of Davy, Mr. Thompson, who collocated the testimony of the two, and from whose

valuable work we made the extracts, seems to coincide.

Now, when such men of deep and careful research, and critical intellectual acumen as Pouillet, Davy, and Thompson *disagree*, and take positions directly opposed to each other, what shall we do, to determine which is right, and which is wrong, for right *both* certainly cannot be? Why, examine critically the positions of each, according to the best light we have, and endeavor, if possible, to ascertain where the *error* lies.

The first subject of investigation is oxygen, which, as we said before, is a very essential agent in the chemical changes which are continually occurring throughout nature.

OXYGEN DISCOVERED BY DR. PRIESTLEY.

This gas was discovered by Dr. Priestley, in 1744. There have, since its discovery, been given several appellations, indicative of its nature. Priestley called it dephlogisticated air. It was called *empyreal air*, by Scheele, and vital air by Condorcet. Lavoisier gave it the name which it now bears, derived from two Greek words which signify *to generate acid*, from its being considered by him the sole cause of acidity.

ITS QUALITIES.

This gas is colorless, has neither taste nor smell, is heavier than atmospheric air, has not, by any experiment hitherto made, been decomposed into non-con-

ductor of electricity, emits both light and heat by the force of sudden compression, and, according to the opinion of some, is the most perfect negative electric in existence, always appearing at the positive pole when any compound which contains it is exposed to the action of galvanism, which opinion we shall, however, endeavor to show is entirely unfounded.

ITS CHEMICAL INFLUENCES.

Oxygen has a very powerful affinity or attraction for most simple substances, and, indeed, it may be made to combine with all. By such combination it oxidizes or corrodes the metal, which oxidation is a species of combustion. It is also the sustaining principle of fire, for the sole reason why fuel burns freely in the open air, or is smothered by cutting off its communication with the atmosphere, is because in the one case its ignition is sustained by its affinity for oxygen, which it attracts from the air, and in the other it is deprived of an appropriate supply to produce the chemical change of vegetable oxidation.

ITS DEFLAGRATING POWER.

All substances which will burn in the open air will deflagrate much more rapidly and brilliantly in oxygen. If there be the least perceptible spark for instance, upon a piece of wood, it will instantly burst into a fierce blaze when inserted in a jar of this gas. And even steel and iron will burn with rapid and intense

brilliancy when thus inserted. The moment, however, that the oxygen is exhausted by chemical combination with the burning body, the ignition ceases, although the substance may not have been entirely consumed.

ESSENTIAL IN RESPIRATION.

There are other interesting phenomena still, which will illustrate the nature of oxygen gas. It seems to be an absolutely essential agent in respiration. No animal can live by inhaling an atmosphere which does not contain a certain portion of oxygen, uncombined with other substances; for he will die very soon, if forced to breathe the air out of which the oxygen has been entirely extracted. If a lighted candle or taper be immersed in it, its flames will be extinguished. Respiration and combustion, therefore, require the presence of the same sustaining agent. An animal cannot live in an atmosphere which is unable to support combustion; nor, in general, can a candle burn in air which contains too little oxygen for respiration.

SOMETIMES FATAL.

There is another singular property about oxygen. Although a certain portion of it is absolutely necessary to sustain respiration, yet an unmixed atmosphere of pure oxygen is as fatal to life as its destitution, though not so speedy in its effects. "When an animal—as a rabbit, for instance—is supplied with such an atmosphere, no inconvenience is at

first perceived, but, after an interval of an hour or more, the circulation and respiration become very rapid, and the system in general highly excited ; symptoms of debility subsequently ensue, followed by insensibility, and death occurs in six, ten, or twelve hours. On examination after death, the blood is found highly florid in every part of the body, and the heart acts strongly even after the breathing has ceased."

ELECTRICAL EFFECTS.

The effects of positive electricity upon carbonated blood are precisely those which oxygen produces upon it in the air cells of the lungs. Draw a bowl of venous blood from the arm, and pass shocks of electricity through it, either from a Leyden jar, or a galvanic battery, or an electro-magnetic machine, and you *arterialize* it—that is, you discharge its carbon, and change its color from a dark purple to a florid red.

From the facts described above, these are the influences, in substance, of oxygen gas. It is the prime agent of the oxydation of all metals, the great supporter of combustion, and gives vitality, warmth, and purity to the blood, as it circulates through the system.

INFERENCES.

Now are these the influences of a negatively electrified body ? Will a substance, which is minus, aid in sustaining flame while one that is plus puts it out ?

Is there anything in the inherent nature of positive electricity to produce such a result? Is it either a principle of cold or dampness, that it should extinguish fire or chill the blood during respiration? It seems to us that any one, who understands the nature of the electric agent, can be at no loss for a ready answer. Even plain, unlettered common sense, could hardly fail of coming to a correct conclusion.

Such properties as belong, inherently to oxygen gas, and such agencies as it exhibits, beyond controversy or the possibility of mistake, in contact with various substances, are entirely inconsistent with the properties and the agencies, which we know belong to negative bodies. Carbonic acid gas, for instance, is a negative body. Does it sustain combustion or respiration, as, reasoning from analogy, we should suppose it would? No. But its influences are directly the reverse of those ascribed to oxygen gas. Instead of sustaining the ignition of fuel, it immediately extinguishes flame, and instantaneously stops respiration, instead of promoting it. Now, if the maxim, that "like causes produce like effects," be a self-evident proposition, as it doubtless is, *can* oxygen gas and carbonic acid gas be *both* negative bodies, when the inherent properties and agencies of the *one* are directly the antipodes of the *other*? The conclusion that they are, must, it appears to us, be considered, when viewed in the light, either of sound logic, or unlettered common sense, as preposterous in the extreme.

The fact is Pouillet was right and Davy and Thompson, his opponents in theory, were wrong. Oxygen gas *is positive*, for no agent can exhibit the same influences, without being positive, if there be any certainty at all in the source of our chemical knowledge.

CAUSES OF MISTAKE.

By a reference to a record of the experiments of Davy and Thompson, from which they draw their conclusions, it will be perceived that the foundation of their mistake might have been in the supposition that certain phenomena attending the decomposition of unmixed water, and of salts of various kinds in solution, with the galvanic battery, must be precisely analogous. They had ascertained that, in such decompositions by the action of galvanism, chlorine, bromine, iodine and acids were attracted to the positive pole, while the alkalies, earths, oxyds, metals and bases of all kinds were attracted to the negative pole.

By means of the delicate test of the condenser, they had ascertained that the first class of substances enumerated were negative and the other positive, and that the chlorine, bromine, iodine and acids were attracted to the positive pole by the mutual attraction of what, according to their theory, they considered unlike electricities, but which we consider unlike polarities of one agent, and that the alkalies, earths, oxyds, metals and bases were attracted to the negative pole by the operation of the same law.

CONCLUSION PLAUSIBLE.

By like experiments they also ascertained that oxygen gas was attracted to the positive pole with just as much certainty and uniformity as the acids, or any other bodies of the most negative character, and that the other constituent of water, the hydrogen gas, with as much certainty and uniformity, was attracted to the negative pole, like the alkalies or the most positive bodies. They, therefore, concluded, and very plausibly, too, that oxygen was negative and hydrogen positive, since they obeyed the same law precisely as other positive and negative substances.

ERRONEOUS.

In such a plausible conclusion consists their error, if in error they really were, and that they were is perfectly evident, since the agencies of oxygen gas are different from those of any known negative, and just such as we should at a glance conclude were positive.

BOUND TO PROVE IT SO.

But if we deny the correctness of their conclusions, we are bound to show, if possible, wherein that error consists. This we are aware will be very difficult to do to the satisfaction of those who may have stubborn prepossessions to overcome. Yet, with, by no means despair of convincing even those, except there be some among them that consider great names a sufficient

demonstration of the truth of a proposition which they may advocate, no matter how lame may be their arguments, or how contrary to fact their reasonings.

OUR ANSWER.

If oxygen gas be positive, why does it disobey that law which, as we have seen, regulates all positive substances, and go to the positive pole, instead of going to the negative, as they all do? Simply because it is a *cause* instead of an *effect*, as in the other cases alluded to. It is electricity, instead of an *effect* merely of electricity.

EXPLANATION.

The acids, being negative, move to the positive pole, because opposite polarities, according to the inherent laws of opposite polarities, bring them there. But oxygen rises from the positive pole for *another* reason *essentially different*. It is constituted by the positive current itself, instead of being collected and constituted by any mere *effect* of that current, and rises, therefore, from its own pole, instead of moving to the negative pole, and there rising.

THE ONLY SOLUTION.

This we conceive to be the *only* rational and plausible, and indeed the only *possible* reason why oxygen, if positive, is uniformly found at the positive pole of the battery, while all negatives move there,

according to the laws of electrical attraction; for, unless it be, as we have assumed, *electricity itself*, instead of any *effect* merely, no reason could be assigned for its moving to that pole, except it were negative, which, as we have already shown, cannot, in accordance with the uniformity of nature's laws, be correct.

OBJECTION.

"But," says the objector to this proposition, "electricity, or galvanism, is an imponderable principle, which exhibits no perceptible weight at all, but oxygen gas is a substance, more dense than most gases, and heavier even than atmospheric air."

ANSWER.

That, we acknowledge, is true. It is heavier than the atmosphere, and electricity exhibits no weight at all, that can be detected by the very nicest and minutest balances. But does this disprove our solution of this apparent anomaly? By no means. It may contain the plus current of the battery, which, however, in its action upon the water, collects to itself certain weighty constituents of that water, which it forms into the vehicle, or medium, in which it is borne, the same as vapor, which is an association of mere vesicles, formed of certain constituents of water, enclosing caloric, the generating agent, which, by the way, will illustrate the formation of oxygen gas.

ILLUSTRATION.

During the generation of vapor by caloric, no positive electric effects are perceptible, according to the testimony of M. Pouillet and Thompson. In this case, caloric is the *cause* of the vapor, arranging for particular use the watery constituents of the vesicle, in which it encases itself, and becoming invisible and imperceptible during that encasement. When, however, by the proximity of any chemical attractions or affinities, which call it forth from its encasement into visibility, and make it burst the vaporous vesicle which it had formed for itself, it then exhibits the phenomena of positive electricity distinctly and strongly marked, as we shall abundantly show when we come to the cause of the nimbification and electrical discharges of the storm-cloud.

LOGICAL CONCLUSION.

Now, what caloric does for itself in the formation of its vaporous vesicle, we consider that the positive current of the galvanic battery does for itself in the formation of an encasement for itself out of certain dense and weighty ingredients of the water, which cause, together with its encasement, constitutes that heavy, invisible, vaporous air, which we call oxygen gas.

IMPERCEPTIBLE WHILE ENCASED.

While thus encased, its positive properties, like the creating agent of the vapor of water, are impercepti-

ble, and are never revealed, except when certain strong chemical affinities, or attractions, call it forth from its imperceptibility, and make it burst asunder the encasement in which it has hidden itself, and show the resistless energies of its nature.

In this way, and in this *alone*, it seems to us, can the appearance of the positive oxygen at the positive pole of the battery, be accounted for, when all other positive substances go to the negative pole. It is a *cause* rather than a *result*. It is positive or plus electricity, so encased as we have described, rather than any effect in the same sense, as the collection of an acid around the positive wire can be considered an effect.

OXYGEN COMPOUND.

Oxygen gas has, ever since its discovery by Priestley, been considered a simple substance, and been thus classified. But the reason of this is, because no chemist has yet been able to decompose it, and demonstrate that it is a compound. There can, however, be no doubt as to its being a compound body, if electricity, in combination with certain ingredients of ponderable matter, can be called a compound body. This is proven by the fact, that although chemists have not been so fortunate as to succeed in decomposing it, it has been decomposed, and is continually undergoing a process of decomposition, in that natural chemical laboratory, far more perfect than any artificial one possibly can be—the *lungs*—as we saw abundantly in another connection.

REASONS WHY CHEMISTS CANNOT DECOMPOSE IT.

Now, the reason why chemists have not succeeded in decomposing this agent, and resolving it into its elements, is, we presume, owing to the fact that the essential or causating principle, is so very subtle, that it cannot be controlled, and so very powerful, that its attractions for its encasement resist all the counter attractions which chemists have arrayed around it.

CHAPTER XVII.

HYDROGEN GAS.

HYDROGEN GAS, which is the opposite of oxygen, will now be briefly examined for a little while, and afterwards we shall remark upon some influences of both in connection, which will further illustrate this subject.

FORMER NAMES.

This gas was formerly called *inflammable air*, from its supposed combustibility, and *phlogiston* from the supposition that it was the matter or principle of heat. But its present name is compounded of two Greek words, which signify to *generate water* from the fact that when changed by combustion, it constitutes water.

As we are obliged, in support of the proposition, that hydrogen is negative, to examine the subject critically, and to show the falsity of prevailing theories upon the subject, we shall first quote the language of a celebrated author, and then examine those sentiments for ourselves. Here follows an extract from Turner.

TURNER'S DESCRIPTION.

"Hydrogen is a colorless gas, when pure, has neither odor nor taste, and is a powerful refractor of light.

Like oxygen, it cannot be resolved into more simple parts, and, like that gas, has hitherto resisted all attempts to compress it into a liquid. It is the lightest body in nature, and is consequently the best material for filling balloons. From its extreme lightness it is difficult to ascertain its precise density by weighing; because the presence of minute quantities of common air or watery vapor occasions considerable error."

ITS QUALITIES.

"Hydrogen does not change the blue color of vegetables. It is sparingly absorbed by water, 100 cubic inches of that liquid dissolving about one and a half of the gas. It cannot support respiration—for an animal soon perishes when confined in it. Death ensues from deprivation of oxygen rather than from any noxious quality of the hydrogen; since an atmosphere composed of a due proportion of oxygen and hydrogen gas may be respired without inconvenience. Nor is it a supporter of combustion; for when a lighted candle fixed on wire is passed up into an inverted jar full of hydrogen gas, the light instantly disappears."

INFLAMMABILITY.

"Hydrogen gas is inflammable in an eminent degree, though, like other combustibles, it requires the aid of a supporter of combustion. This is exemplified by the experiment above alluded to, in which the gas is kindled by the flame of a candle, but burns only where

it is in contact with the air. Its combustion, when conducted in this manner, goes on tranquilly, and is attended with a yellowish blue flame and a very feeble light. The phenomena are different when the hydrogen is previously mixed with a due quantity of atmospheric air. The approach of flame not only sets fire to the gas near it, but the whole is kindled at the same instant; and a flash of light passes through the mixture, followed by a violent explosion. The best proportion for the experiment is two measures of hydrogen to five or six of air. The explosion is far more violent when pure oxygen is used instead of atmospheric air, particularly when the gases are mixed together in the ratio of one measure of oxygen to two of hydrogen."

DIFFICULT TO COMBINE OXYGEN AND HYDROGEN.

"Oxygen and hydrogen gases cannot combine at ordinary temperatures, and may, therefore, be kept in a state of mixture without even gradual combination taking place between them. Hydrogen may be set on fire, when in contact with air or oxygen gas, by flame, by a solid body heated to bright redness, and by the electric spark. If a jet of hydrogen gas be thrown upon recently-prepared spongy platinum, this metal almost instantly becomes red-hot, and then sets fire to the gas, a discovery which was made in the year 1824, by Professor Doebereiner, of Jena. The power of flame and electricity, in causing a mixture of hydrogen *with* air or oxygen gas to explode, is limited.

DISCOVERIES OF CAVENDISH

Mr. Cavendish found that flame occasions a very feeble explosion when the hydrogen is mixed with nine times its bulk of air; and that a mixture of four measures of hydrogen with one of air does not explode at all. An explosive mixture, formed of two measures of hydrogen and one of oxygen gas, explodes from all the causes above enumerated.

INVESTIGATIONS OF BIOT.

"Biot found that sudden and violent compression likewise causes an explosion, apparently from the heat emitted during the operation; for an equal degree of condensation, slowly produced, has not the same effect. The electric spark ceases to cause detonation, when the explosive mixture is diluted with twelve times its volume of air, fourteen of oxygen, or nine of hydrogen; or when it is expanded to sixteen times its bulk by diminished pressure. Spongy platinum acts just as rapidly as flame or the electric spark in producing explosion provided the gases are quite pure and mixed in the exact ratio of two to one.* Mr. Faraday finds that platinum foil, if perfectly clean, produces gradual

* For a variety of facts respecting the causes which prevent the action of flame, electricity, and platinum, in producing detonation, the reader may consult the essay of M. Grotthus, in the *Ann. de Chimie*, vol. lxxxii.; Sir H. Davy's work on Flame; Dr. Henry's essay in the *Philosophical Transactions* for 1824; and a paper by myself in the *Edinburgh Philosophical Journal* for the same year.

though rather rapid combination of the gases, often followed by explosion." (Phil. Trans. 1834.)

DAVY'S OBSERVATIONS.

"When the action of heat, the electric spark, and spongy platinum no longer cause explosion, a silent and gradual combination between the gases may still be occasioned by them. Sir H. Davy observed that oxygen and hydrogen gases united slowly with one another, when they are exposed to a temperature above the boiling point of mercury, and below that at which glass begins to appear luminous in the dark. An explosive mixture, diluted with air to too great a degree to explode by electricity, is made to unite silently by a succession of electric sparks. Spongy platinum causes them to unite slowly, though mixed with one hundred times their bulk of oxygen gas."

FACTS AND CONCLUSIONS EXAMINED.

In the examination of this subject, and in commenting upon the facts developed and the positions taken in the extract, we shall do it in the order in which they occur in that extract.

HYDROGEN CANNOT SUPPORT RESPIRATION.

It is said that "hydrogen gas cannot support respiration." And why not? It is affirmed that it is not because it contains any deleterious quality, but because it is simply deficient in oxygen. We grant that

all this is true. It will not support respiration, and consequently life, when unmixed with oxygen, simply for the want of that oxygen.

Now what is there in the oxygen and not in the hydrogen, which supports respiration and life? We affirm that it is *positive* electricity, with which the oxygen is charged, and of which the hydrogen is almost entirely deficient. By examining the phenomena of respiration in the strong light of the facts, which chemistry throws upon the subject, we shall be convinced that this is the case. What are the phenomena of respiration?

PHENOMENA OF RESPIRATION.

When atmospheric air is drawn into the lungs by inhalation, a remarkable chemical change takes place, through its influence upon the dark venous blood in its passage through the lungs, where, in the innumerable veins, and air cells it comes in contact with the atmosphere. The oxygen of the atmosphere is decomposed, the imponderable principle of the oxygen, or its electric cause, enters into the blood, neutralizes by a chemical change, certain deleterious properties, which, if retained in the blood, would destroy life, the ponderable encasement, of the imponderable principle, whatever that encasement be, is exhaled again, the blood changes from a dark purple to a florid red color, in part by being unloaded of its carbon, and the streams of life are purified from all stagnating

causes and qualities, vivified and filled with their vital and energizing warmth, by the electricity infused into them. Is not this, in brief, the reason why oxygen gas is necessary for the support of life? Is not animal heat or the heat and consequent fluidity of the blood caused by the positive electricity contained in it? Is not this in fact, the principle of mere animal life, since the blood is that animal life?

NOT NEGATIVE EFFECTS.

Were this gas *negative*, could its effects upon the blood be such as we find them? Could a *negative* body impart *heat* at all, since the absence of electricity is the absence of the *essential principle* or fire of heat? The appropriate answer to these questions is perfectly obvious. All must, we think, from these facts and reasons, conclude that oxygen is, and *must* of necessity be, *positive*, and hydrogen is consequently *negative*, since it is the very opposite of oxygen. But there is still further proof to be drawn from the extract itself.

FURTHER PROOF.

Some there may be, who may still affirm with the books, that hydrogen must be positive, since it is known to be "inflammable in an eminent degree," in the language of the extract from Turner, and, therefore, contrary to the assertions above, it must contain the principle of fire. But chemists have been entirely at fault in this position. The fact is, it is *not inflammable*

at all, which fact is capable of such lucid and perfectly logical demonstration, as must satisfy every ingenuous and unprejudiced mind.

NOT INFLAMMABLE.

Although hydrogen is affirmed to be inflammable, yet, it is said, in the same breath, that it is "not a supporter of combustion," which is a palpable contradiction in terms. Can any substance contain the principle of fire, or be combustible, without having at the same time the power to sustain combustion? The thing is impossible. "When," in the language of Turner, "a lighted candle, fixed on a wire, is passed up into an inverted jar full of hydrogen gas, the light instantly disappears." Now why is this? If hydrogen were *inflammable*, would it put out fire? The idea is perfectly absurd. One might just as well, and with just as much reason affirm, that fire would put out fire, as to affirm that inflammable gas would put out fire.

DIFFERENT EFFECTS OF THE GASES.

To show the difference between the two gases, if a lighted candle be inserted in a jar of hydrogen, it will be extinguished, but if there be the least spark or smoke at the end of the wick, and it be inserted in a jar of oxygen, it will be instantly relighted, and so, by inserting the candle alternately in hydrogen and oxygen, it will alternately be put out and relighted, until the two gases escape, or the candle is consumed.

Now, which appears by this experiment, the most luminous gas, hydrogen or oxygen? The one that sustains flame, and the other relights it. Which, therefore, seems to be *hydrocarbonic*? Common sense can solve that question, and this must be its answer: *hydrocarbonic* must be *hydrocarbonic* which will aid to a *body*, instead of extinguishing it when on fire.

JERRY ANSWERED.

But the question may here be asked, Why hydrogen gas will burn, as in the cases enumerated in the course we are considering? We answer, unhesitatingly, that it will not burn at all—that it never did and never will. It will inflame, it is said, by the application of a lighted candle, when in contact with atmospheric air, which contains oxygen, or else in contact with pure oxygen itself. But why is this? Why must it come invariably in contact with a *supporter* of combustion? Simply for this reason: The hydrogen is negative, and the oxygen is positive. That positive contains the principle of fire, or electricity, and is, therefore, a supporter of combustion. The negative is the entire absence of the principle of fire. The one is, therefore, highly plus, and the other deeply minus, and when they are mixed, either by contact with the atmosphere, or with a certain proportion of the two gases pure, they unite upon the application of flame, with an explosion. This union and explosion are precisely in accordance with the own principles of electrical attraction. Between

the two there exists the strong affinity of opposite polarities. The plus of the one is given out to the minus of the other, and this combustion is the result. That the fire depends, not upon the hydrogen, but upon the oxygen, for when it gives out its plus to the minus of the hydrogen, in the effort to restore an equilibrium between two opposites, that plus charge appears in the form of fire. This and this *only*, it appears to us, is the cause or reason of the combustion, and must prove conclusively, that oxygen is highly positive, while hydrogen is deeply negative. There can not possibly, it seems to us, be any rational doubt about it.

PHENOMENON OF SPONGY PLATINUM.

There is another fact still in the extract, which, if left unexplained, may lead to false conclusions. It is this. "If a jet of hydrogen gas be thrown upon recently prepared spongy platinum, this metal almost instantly becomes red hot, and then sets fire to the gas." Now this question may occur—if hydrogen be not *inflammable*, and if it contain not the principle of heat, how can it make the platinum *red hot*? This question we shall answer, by denying that any such effect is caused by the hydrogen simply. There is another way to account for the phenomenon—a way in more strict accordance with the known laws of chemistry.

EXPLANATION.

Platinum is a positive substance and is so classed in the list of positive substances, and hydrogen is negative, as we have seen. Now, when a jet of this gas is thrown upon the spongy platinum, why does that metal become red hot, unless the positive charge of the hydrogen make it so? This is the *philosophical* solution of the question. The hydrogen, being deeply minus, while the platinum, in comparison, is highly plus, the electricity or latent caloric of the metal rushes to its surface, where, by strong chemical affinities, a deeply minus substance calls it out and makes the plus substance red hot, by its own latent caloric, becoming visible. This is the law precisely of all *galvanic* action, and indeed of all *chemical agencies* whatever. A metal can be affected or decomposed in *two* ways. If a substance, highly plus, be brought, in solution or in the form of a gas, in contact with the metal, so as to have the facility, by that contact, of taking hold of its particles, the plus substance will decompose the metal more or less rapidly, in exact accordance with the difference in the respective amounts of latent caloric or electricity, which they contain.

SOLUTION OF GALVANIC ACTION.

If this position be correct, as it doubtless is, then we have a correct solution for the action of the galvanic battery.

associated plates of zinc and cop-

per, composing the battery, are plunged into a strong solution of nitric acid, the zinc plate is attacked by the acid, instead of the copper. And why? Because it is more positively charged than the copper. Rapid decomposition of the zinc is the consequence. And why? Because, it being plus and the acid minus, the latent caloric of the zinc, or its electricity, which makes it plus, *burns* its way out through the metal, to the deeply negative body, which surrounds that metal, and thus decomposition takes place, latent caloric is set free by burning up the metal in its passage to the minus substance, for which it has a stronger affinity, and during this change, a portion of it escapes by the conducting poles of the battery.

SAME ACTION ON COPPER AS ON ZINC.

The acid would act upon the copper in the same way it does upon the zinc, were it associated with some other metal which should be *relatively* minus, or have less latent caloric than itself. This is proven from the fact, that, although the solution of nitric acid will not materially affect the copper, when associated with the zinc, yet, when the same acid is poured upon the copper by itself, the copper is rapidly consumed, the latent caloric burns its way out to the minus acid, and, during the decomposition, which is attended with no small commotion, a purple vapor rises, which has almost the appearance of flame.

PHENOMENA OF OXYDS.

But oxygen gas corrodes, or burns, or decomposes the metals for a reason just the *reverse* of that which we have assigned for the action of the acids upon them. It is highly positive or plus, and therefore imparts its latent fire, caloric or electricity, just which you please to call it, to the metals, instead of receiving it *from* them, as the acids do, when in contact with them. The consequence is, that it burns them to ashes silently, as in the corrosion or oxydation of the metals, exposed to a damp atmosphere, or with an intensely brilliant corruscation, as in their deflagration, when inserted in a jar of pure oxygen.

CONCLUSION.

We dismiss this subject of the various influences and agencies of oxygen and hydrogen, but more particularly of oxygen, not because it has been exhausted by any means, nor because it could not be extended with interest, for there could be a volume written without exhausting it, but because the design and limits of this work will not permit. Enough, however, has been said, we think, by way of argument and proof, to demonstrate to the perfect satisfaction of every mind that is willing to be satisfied, that oxygen gas is positive, and hydrogen gas is negative, and that the opinions of Pouillet upon this subject were right, and those of Davy and Thompson were wrong. Enough has also

said to show conclusively that electricity is an
agent in the chemical changes which we wit-
ness around us, and which are continually occurring
throughout nature, and to prove that the actual cause
of any of the wondrous phenomena which come under
the observation of chemists has been mistaken.

CHAPTER XVIII.

A NEW FIELD.

WE intend, in the present chapter, to examine the chemical effects of electricity in another important department, perhaps the *most* important of human knowledge, into which we have not, as yet, introduced the reader. We feel, as we enter it, our incompetency to do anything like justice to the subject, for the agencies of electricity in the production of animal life—its indispensable necessity in the preservation of that life, and its remedial qualities open a vast field of most interesting investigation before us—a field hitherto but little explored—a field, every part of which is full of such marvellous interest, that the Psalmist very properly exclaims, when contemplating it, "*I am fearfully and wonderfully made.*"

CALORIC ESSENTIAL TO LIFE.

If, in passing from the contemplation of inorganic matter to organic, we range through the various departments of the vegetable kingdom, and the lower order of animated existences, we find that the electric agent, or caloric, which we shall hereafter prove, is the same thing, is the grand *instrumental* cause of the germina-

tion of life. No acorn ever burst its shell and rose into a stately monarch of the forest—not one of the ten thousand various seeds of trees, of herbage and of flowers that clothe and variegate the landscape, ever vegetated without the agency of heat. They would, forever, have lain dormant and lifeless in the cold and withering embrace of the earth, and, unwarmed into life by the genial influences of the caloric of the sunlight, this globe would have been covered with a chilling desolation, as blank as that of an iceberg, and no more vegetation would have adorned it in a vesture of green, than would now spring up on the snow-banks of a December in Nova Zembla.

ANIMAL LIFE.

When we pass from the vegetable to the *animal* kingdom, we find the same great truth illustrated by a thousand facts. What generates life in the egg of the feathered tribe, and sustains and fosters it from the mere incipient embryo of existence, to the bursting of the shell by the little chick, as he starts into animation from his prison-house? Why *caloric*, and *caloric alone*? If the hen, or any other animal of the feathered tribe, fails to brood over the eggs with unwearied constancy—if, during any portion of the gradual stages of the progression of existence, from the incipient enlargement of the impregnated ovary, to the period when the shell is burst, the egg is left to cool below the equal temper-

ature of animal heat, it becomes addled immediately and the principle of animation departs.

Even where there is no incubation of the animal, the egg is still hatched by the agency of caloric. The ostrich buries hers in the sands of the desert in the torrid zone, where she leaves it to be warmed into life by the influences of a vertical sun. The serpent of the same zone, it is said, follows the example of the ostrich, and, by the germinating power of the heated sand-hills, peoples the burning wastes of Sahara with her venomous brood. Even that industrious little spinster, the silk-worm, that fabricates from leaves, the imperial robes and vestments of monarchs, is brought into life by a similar process—by the application to the ovum of either natural or artificial heat.

CALORIC AND ELECTRICITY IDENTICAL.

But, although it may here be confessed, that caloric is absolutely necessary to the production of those forms of existence, to which we have alluded, yet it may be denied that this acknowledged generating agent is electricity, as we have affirmed. Leaving our main argument in proof of the position we have assumed, until we come to the subjects of solar light and heat, we would here ask, if caloric and electricity be not inseparable? Was there ever a distinct electric phenomenon of any kind, ever developed to the exclusion of caloric, or of any body else, without the simultaneous development of caloric, at the same time, of a corres-

ponding amount of heat; or, more properly speaking is not the electricity developed, in fact, nothing more nor less than the caloric, which is inseparably attendant upon every such development.

EFFECTS OF FRICTION.

Friction is one of the main causes of the production of electricity. If amber, for instance, be rubbed, or a stick of sealing wax, they immediately become electrically excited, and will prove it by attracting to themselves contiguous light bodies. This is the case with a glass tube, or any other electric, when rubbed with dry silk, or woollen cloth. It is a fact well worthy of attention and remark, that *heat* is invariably produced by that friction. Now, are not the electrical phenomena, which are manifested by that friction, owing entirely to the latent caloric which is called out, and made visible, since it is ever developed by the exciting cause? Let us examine the catalogue of electrical facts, and see if we do not find still further confirmation of the proposition we have assumed, and sufficient to convince the sceptical.

GAS OF COMBUSTION.

According to the experiments of M. Pouillet, already recorded in this work, the gas that rises from burning charcoal is positively electrified. What is that but the evolution of caloric in a certain form?

HEATED METALLIC RODS.

By heating metallic rods at one end, and thus disturbing the equalization of their temperature, electric or magnetic phenomena make their appearance ; for one end of such rods will be positive and the other consequently negative, as is exhibited plainly by their attractions and repulsions of the electrometer or magnetic needle. Here the character of the electrifying agent is so perfectly apparent, that there can be no mistake at all about it. It is caloric and nothing but caloric.

HEAT BY GALVANIC ACTION.

The galvanic battery in action, always produces heat. If the acidulated solution, into which the battery is plunged, is perfectly cold at the time of its immersion, that solution will be heated so rapidly, that it will, in some cases actually boil in less than three minutes. Now, what causes this great and sudden change in the temperature of the solution, except it be the latent caloric of the zinc set free by the process of the combustion of the metal, heretofore described, and which constitutes the galvanic current, and produces the galvanic effects of the battery? We feel that candid minds must be irresistibly brought to the same conclusion by these facts. That caloric, which heats the solution, must be the electric agent, and that electric agent, the caloric. There can possibly be no mistake about this.

HEAT BY CRYSTALLIZATION.

All crystallizations of salts, and other crystallizations of whatever character they may be, exhibit electrical phenomena, and are always attended with the evolution of caloric. All freezing mixtures expel caloric rapidly, and evolve also electricity. According to the estimate of Dr. Hare, of Philadelphia, the crystallization of vapor, which attends a snow storm, gives out more caloric than a shower of red hot pulverized glass, and we know that such crystallization of vapor is accompanied with electrical phenomena.

FURTHER DISCUSSION DEFERRED.

The further elucidation of the identity of caloric and electricity will be referred to its appropriate place—the discussion of the subject of solar heat, since in this connection, it is rather a digression from the topics we had selected. We shall there collocate, we think, such a formidable array of additional facts, as must convince the most sceptical unbeliever. But enough has been said, we presume, to prove that the caloric, which is the cause of the germination of all seeds, and the principle, which vivifies the embryo of the egg, is electricity, and produces these effects by the known chemical influences of that agent.

With the single remark, that, if the subject be closely scrutinized, it will be apparent to every one, that the reproduction and continuation of every species of

animals, as well as vegetables, are owing to an *electric cause*, we pass on to the consideration of other important topics connected with this subject.

ITS PRESERVING AGENCY.

Having shown that caloric or electricity is the generating agent of mere animal life, we shall now endeavor to show that it is a more essential agent in the continuance of that life, and in the preservation of health, than we have, at a superficial glance, been apt to imagine.

HEALTH DEFINED.

Health, we consider, to be the equilibrium of the electrical condition of the human system, for instance, and the more perfect that equilibrium the more perfect the health.

DISEASE DEFINED.

Disease, on the contrary, is either a plus or a minus of the whole system, or else an unequal electrical condition of the system, making one part plus and the other part minus, and thereby causing obstructions and stagnation of the vital fluid.

We will, for a moment, examine into the condition of the human system, when minus, and ascertain whether the facts in the case will sustain our theory.

MINUS CONDITION.

What are the phenomena, for instance, attending

the distressing complaint of diarrhoea, cholera morbus, or Asiatic cholera? The system is in a deeply minus condition. The surface is cold, the blood scarcely circulates in the external channels of its passage, or in the veins, leaving the extremities in a chilled condition, the skin assumes a bluish cast, no perspiration starts from the system, but if there be any moisture, it is a cold clammy suffusion, the same as dew, having left the surface and extremities, the vital current rushes with tremendous pressure upon the heart and main internal arteries, the delicate membranous coatings of the stomach and alimentary canal become turgid and inflamed, and, in some cases, raw, ulcerated, and suffused with blood; the breathing is labored, as though the lethargies of a nightmare pressed upon the vital apparatus, the breath becomes hot and scalding, and death makes rapid and giant strides upon the debilitated constitution.

CHEMICAL CAUSE.

Now for an explanation of the chemical cause of this condition of the system. It will be found, upon the closest scrutiny, that, in ninety-nine cases out of a hundred, when the above symptoms make their appearance, the stomach is filled with a cold, slimy, ropy, indigestible load, which is, of course, a deeply minus or negative substance. Now what are the *chemical* consequences of this negative substance upon the system? They are deleterious in the extreme, as will be ex-

plained by a reference to an experiment in a former chapter. It will be recollected that we demonstrated that if a current of galvanism be passed in to the tongue, it produces an acid taste in the mouth. This proves that an inward current of electricity is, in some mysterious way, the generator of acidity, which, as we have shown abundantly in another connection, is the reason why all acids are minus bodies.

The contents of the stomach, being minus or acid, will, of course, have an attraction for the plus or alkaline polarities of electricity, and the current will, therefore, be inward from the surface, which will be left cold, while those burning alkaline polarities will irritate the internal coats of the stomach and intestines, the same as they are irritated in the cholera and other kindred diseases, and produce, according to strict chemical laws and agencies, all the fearful effects of those distressing and often fatal complaints.

A CASE IN ILLUSTRATION.

There is a case directly in point, which came under our own observation, and which will forcibly illustrate both the effects and phenomena of the disease we have been describing, and the appropriate chemical remedies for that disease.

Some years ago, a young man, a printer by profession, while boarding in our family, was attacked one night most violently with a complaint almost akin to the Asiatic cholera. Being reluctant to trouble the family, he

made no one acquainted with his situation during the night, and, rising early in the morning, we found him lying upon the stairs, where he had reclined, almost perfectly helpless and exhausted, in his passage to his chamber. Seeing him in this miserable condition, we roused him and aided him to his bed. As soon as there was light enough to see his complexion, we discovered that the surface and extremities of his system had a cold, bluish appearance, almost like the collapsed or lethargic state of the cholera, he was racked with violent and almost spasmodic pains, and was evidently sinking very rapidly into the arms of death.

OUR REMEDY.

We dispatched a messenger immediately for a physician, but feeling that medical aid might possibly come too late, we concluded to do what we could in the meantime to check the disease. Knowing that he had often complained of acidity of stomach, and thinking that this must be the primary cause of the distressing complaint under which he was groaning, we determined to administer relief upon strictly *chemical* principles. We accordingly mixed a tumbler of very strong sal soda, which he drank. We then took a large fold of coarse flannel, filled it full of fourth proof brandy, and sprinkled it over thickly with ground black pepper. This we spread over his stomach and bowels, and then covered him with an extra quantity of bed clothes. The result was surprising

and almost magical. In less than twenty minutes an active reaction took place in his system. The cold, blue complexion left the surface, the countenance put on the natural hue of health,—a moist perspiration started out, the racking pains left him entirely, and he recovered immediately without further medical assistance.

LOGICAL INFERENCE.

Now, in this case, it is perfectly evident, that the cause of the disease was acidity. The matter in the stomach was deeply minus, the current of electricity was therefore *inward* instead of being *outward*, and the surface and extremities were consequently left cold, the blood, in thickened, stagnated streams, pressed upon the heart and internal arteries, and while the extremities were almost rigid, the internal apparatus of vitality was parched with a burning, withering heat.

To restore healthy action again, all that was necessary was simply to reverse this order of the electrical condition of the system. This was done by neutralizing the minus with a plus *internally*, or an acid with an alkali, so as to give the current of electricity an *outward* instead of an *inward* direction, by making the contents of the stomach plus, which would, of course, leave its internal coatings minus, and by aiding that outward current by the external application of brandy and pepper. Thus was the effect removed by removing the cause of the effect.

CHAPTER XIX.

OTHER DISEASES.

THERE are other diseases that can be just as speedily cured by understanding fully the electrical condition of the human system, and then by making such an application of chemical remedies as to neutralize the cause.

PULMONARY COMPLAINTS.

Pulmonary complaints can be cured in ninety-nine cases out of a hundred, where internal irritation or inflammation is the cause, by external blistering, or frequent and severe friction, provided it be attended with proper exercise and diet. And why? Because it is an invariable law, that, if the outer surface is plus, the inner is minus, and if the outer is minus, the inner is plus.

Now, if the inner be plus or inflamed, what is to be done? Why simply produce a counter irritation by blistering or otherwise, and keep up that irritation sufficiently long to permit all ulcerous affections to heal, as they will, when the current of electricity is outward, as we shall illustrate more fully after having entered into an examination of the blood and its agencies.

This examination we shall preface by an extract from Liebig's - Animal Chemistry."

EXTRACT FROM LIEBIG.

- If we hold, that increase of mass in the animal body, the development of its organs, and the supply of waste—that all this is dependent on the blood, that is, on ingredients of the blood, then only those substances can properly be called nutritious, or considered as food which are capable of conversion into blood. To determine, therefore, what substances are capable of affording nourishment, it is only necessary to ascertain the composition of the food, and to compare it with that of the ingredients of the blood.

TWO SUBSTANCES CONSIDERED.

Two substances require especial consideration as the chief ingredients of the blood; one of these separates immediately from the blood when withdrawn from the circulation. It is well known that in this case blood coagulates, and separates into a yellowish liquid, the *serum* of the blood, and a gelatinous mass, which adheres to a rod or stick in soft, elastic fibres, when coagulating blood is briskly stirred. This is the *fibrine* of the blood, which is identical in all its properties with muscular fibre, when the latter is purified from all foreign matters.

The second principal ingredient of the blood is contained in the serum, and gives to this liquid all the

properties of the white of *eggs*, with which it is identical. When heated it coagulates into a white elastic mass, and the coagulating substance is called *albumen*.

ELEMENTS OF THE TWO.

Fibrine and albumen, the chief ingredients of blood, contain in all seven chemical elements, among which nitrogen, phosphorus and sulphur are found. They contain also the earth of bones. The serum retains in solution sea salt and other salts of potash and soda, in which the acids are carbonic, phosphoric and sulphuric acids. The globules of the blood contain fibrine and albumen, along with a red coloring matter, in which iron is a constant element. Besides these, the blood contains certain fatty bodies in small quantity, which differ from ordinary fats in several of their properties.

Chemical analysis has led to the remarkable result, that fibrine and albumen contain the same organic elements united in the same proportion, so that two analyses, the one of fibrine and the other of albumen, do not differ more than two analyses of fibrine or two of albumen respectively do, in the composition of one hundred parts.

IDENTICAL.

In these two ingredients of blood, the particles are arranged in a different order, as is shown by the difference of their external properties; but in chemical

composition, in the ultimate proportion of the organic elements they are identical.

CONCLUSION CONFIRMED.

This conclusion has lately been beautifully confirmed by a distinguished physiologist (Denis), who has succeeded in converting fibrine into albumen, that is, giving it the solubility and coagulability by heat which characterize the white of egg.

Fibrine and albumen, besides having the same composition, agree also in this, that both dissolve in concentrated muriatic acid, yielding a solution of an intense purple color. This solution, whether made with fibrine or albumen, has the very same reactions with all substances yet tried.

Both the albumen and fibrine, in the process of nutrition, are capable of being converted into muscular fibre, and muscular fibre is capable of being converted into blood. These facts have long been established by physiologists, and chemistry has merely proved that these metamorphoses can be accomplished under the influence of a certain force, without the aid of a third substance, or of its elements, and without the addition of any foreign element, or the separation of any element previously present in these substances.

If we now compare the composition of all organized parts with that of fibrine and albumen, the following relations present themselves :

NITROGEN AN ELEMENT.

All parts of the animal body which have a decided shape, which form parts of organs, contain nitrogen. No part of an organ which possesses motion and life is destitute of nitrogen ; all of them contain, likewise, carbon and the elements of water, the latter, however, in no case in the proportion to form water.

The chief ingredients of the blood contain nearly 17 per cent. of nitrogen, and no part of an organ contains less than 17 per cent. of nitrogen.

The most convincing experiments and observations have proved that the animal body is absolutely incapable of producing an elementary body, such as carbon or nitrogen, out of substances which do not contain it, and it obviously follows, that all kinds of food fit for the production either of blood or of cellular tissue, membranes, skin, hair, muscular fibre, &c., must contain a certain amount of nitrogen, because that element is essential to the composition of the above-named organs ; because the organs cannot create it from the other elements presented to them ; and, finally, because no nitrogen is absorbed from the atmosphere in the vital process.

BRAIN AND NERVES.

The substance of the brain and nerves contains a large quantity of albumen, and, in addition to this, two peculiar fatty acids, distinguished from other fats

by containing phosphorus (phosphoric acid). One of these contains nitrogen (Fremy).

WATER AND FAT.

Finally, water and common fat are those ingredients of the body which are destitute of hydrogen. Both are amorphous, or unorganized, and only so far take part in the vital process as that their presence is required for the due performance of the vital functions. The inorganic constituents of the body are iron, lime, magnesia, common salt and the alkalies."

OUR COMMENTS UPON THE EXTRACT.

The above extract from Liebig, though a partial digression, has, nevertheless, been introduced because it contained two important facts—first, that the increase of growth and weight in the human system depend mainly or wholly upon the blood, and secondly, that the blood contains all those inorganic constituents of which the organic is composed. The blood, then, it seems, is the chief agent in the distribution to different parts of the system, of the nutriment, which either builds or repairs the organic structure, and supplies what is wasted.

AGENTS OF CHEMICAL CHANGE.

All the chemical changes, then, which transform the vegetable and animal nutriment into chyle, the chyle into blood, and the blood into flesh, and bones, and

nerves and muscles, the gastric juice, the saliva, the tears, and every other secretion, are performed through the medium and influence of the heart, veins and arteries.

IMPORTANT QUERY.

A very interesting question here suggests itself naturally to the mind, respecting the particular cause and the "modus operandi" of these multiform agencies, whose solution we confess is very difficult, but which can be somewhat elucidated by certain familiar facts of ordinary occurrence, from which some common sense conclusions can be logically drawn. How does the blood resolve the constituents of food into flesh, or distribute its healthful and nutritious qualities into the organic mass of the system, and expel from that system those portions which are deleterious to animal life and vigor?

AGENCY THAT PURIFIES THE BLOOD.

These questions can better be answered after examining the phenomena of respiration. The blood, when simply considered in regard to its ponderable elements, has no inherent power whatever to produce chemical changes, and to convert food into the component materials of the system, and separate that which is baleful and healthy from that which is not. That agency, so powerful and wondrous, belongs to the imponderable principle of the oxygen gas, wh

is inhaled by respiration, and to that *alone*, and that, as we have heretofore abundantly proven, is positive electricity. The all-pervading electric agent, after all, does the work. And, what are the phenomena attending some of its operations?

THE LUNGS A LABORATORY.

The lungs, as we have seen, are the grand laboratory where almost the whole chemical changes of the human system are effected. In them the venous blood is transformed to the arterial, for the venous blood is one substance and the arterial quite another—that is, the one possesses some ingredients which the other does not, or else the one possesses some ingredients in greater proportion than the other. The venous blood in its passage through the veins, along the courses of the lymphatics, and by the absorbents and secretory organs of the system, brings along a load of carbon and other matters deposited by the food in different parts which are at war with life, and which, if not expelled from it, would bring this wondrous but frail tenement down into the unorganized mass of mere lifeless material out of which it was constructed—the venous blood, we say, brings along this load in its passage through the lungs, and there exposes it to the action of the oxygen of the atmosphere, by which it is all decomposed when the breathing apparatus performs its appropriate duties. The carbon is expelled in the form of carbonic acid gas, a most deleterious poison, and

other pernicious materials find vent in the same way. The blood being purified from those substances, which will not aid in the construction, stability, and healthiness of the organic system, and changed or arterialized from a dark purple to a florid red color, bounds its gladsome course with greater elasticity, making the spirits buoyant, and spreading the flush of health over the cheeks.

DEFECTIVE LUNGS.

From these facts, which are incontrovertible, and can be tested, it will be very readily perceived what must be the fatal or pernicious consequence of any defect in the chest, either natural or acquired by those sedentary or slothful habits by which the breathing apparatus is circumscribed or compressed, so that the cells cannot be expanded and completely filled at every inhalation by the vivifying and purifying oxygen. By such defect it is evident that but a small portion of oxygen would be brought in contact with the blood. Of course but a small quantity of these deleterious substances, about which we have remarked, would be decomposed and expelled by it. Being retained in the system, they would aid to pull down rather than build up, to enfeeble rather than strengthen the body; the lungs would become tuberculous and ulcerated, the liver inflamed, the heart and the arterial system diseased, and the citadel of life would be prematurely and inevitably stormed and captured by the invading forces.

APPROPRIATE INFERENCES.

How very essential is the knowledge of this fact to parents, guardians and teachers in the physical education of children committed to their care and culture. If they would give them a healthy constitution, they must pay particular attention to the development of this curious apparatus of animal life—the grand laboratory in which are wrought the chemical changes, the decompositions and the recompositions that build up and beautify, or pull down and deform the organic structure ; for, to use an appropriate figure, the lungs are the furnace, the blood is the liquid of life, and oxygen is the fuel that heats it up, and makes that steam engine, the heart, propel the streams of vitality through all their purple channels. If the furnace be compressed from any cause—if it be cramped and small—the quantity of fuel consumed will, of course, be proportionably less ; feebler will be the strokes of that engine, and more dull, languid and stagnated will be the current of life.

DEFECTIVE EDUCATION.

It is plain, then, that the system of hothouse culture which prevails to too great an extent at the present day, is *all wrong*. Children should not be brought up in the shade. They should be permitted and encouraged to engage in those animating sports, in the open air, which quicken the respiration, and inflate

and distend to their utmost capacity every air cell of the lungs. Yes, they should snuff up with delight the brisk breezes, and face the keen north-wester when Fahrenheit is five or ten degrees below zero. By such a course of physical education, it is perfectly evident that the foundation must be laid for a healthy constitution, by giving a round, full development to the organs, in which the streams of life are purified and prepared for the healthful construction of the physical organization.

VERY IMPORTANT FACTS.

In this connection we will notice a few phenomena, whose cause is not generally understood, and which will throw light upon this interesting subject we are discussing.

It is a fact, well known to every observer, that children consume vastly more food in proportion to their bulk than adults, but the reason *why* they do is not so obvious. There is, however, a definite chemical cause. Children breathe much more rapidly than grown persons, they, therefore, inhale a much greater quantity of oxygen gas; this decomposes and prepares the food for organization into the living mass much faster, and, for this reason alone, a healthy child eats sometimes as much or more than an adult of four or six times his bulk, and grows, therefore, proportionably faster. This, too, is the reason why a child cannot bear the sawings of hunger, and wants to eat oftener, and,

therefore, sometimes becomes a source of extreme annoyance to the careful and economical provider who does not understand the cause.

EFFECT OF RAPID BREATHING.

Owing to rapid breathing, "a bird, deprived of food, dies on the third day, while a serpent, with its sluggish respiration, can live without food three months and longer," as has been proven by those enormous anacondas, who have swallowed deers whole, and then lain torpid for whole months, while the food is undergoing the slow process of digestion.

LABORERS REQUIRE MORE FOOD THAN IDLERS.

The reason why a laboring man requires more food than one who does not labor at all, is this: His respiration is more rapid and the volume of air is greater at each respiration. The amount of oxygen, therefore, being greater, a larger amount of food is of course burned or decomposed by that oxygen, and so a greater amount is necessary to supply the exhaustion. It is worthy of remark, also, that the pulsations of the blood are proportionably quickened by the inspired oxygen, which shows that it imparts caloric or electricity to the fluid, in proportion as it is inhaled.

FACTS MULTITUDINOUS.

A thousand other facts upon this subject, respecting the reason why we require more food in the winter

than in the summer—why the inhabitants of the polar regions eat more and heartier than those in the torrid—why a child requires more sleep than an adult, and a laboring man than an idle one—why sedentary persons are simultaneously afflicted with the loss of appetite and a disinclination to sleep—and why the blood of a person is just as warm in Nova Zembla as on the desert of Sahara, might be enumerated until this fruitful subject alone should extend out into a volume. Our limits however, forbid an extension. Suffice it, therefore, to remark, that all these facts, and many others which might be enumerated, result from certain invariable chemical changes wrought by the electric agent.

A PLUS CONDITION.

As in another part of this work, we have given the phenomena of a diseased body when minus, and suggested the appropriate remedies, we will now for a moment take into consideration one charged plus, or a person afflicted with a raging fever. Some of the symptoms are a flushed countenance, turgid veins, a parched tongue, a head ache owing to a rush of blood to that region, quickened and violent pulsation, rapid and labored breathing, and a hot, dry, husky surface. And now what are the chemical causes and the appropriate chemical remedies for such a state of the system? Owing to a cold or some other cause, the natural, healthful perspiration of the body, by which a proper electrical condition expels certain impurities,

is checked and entirely stopped by the closing of the pores. The consequence is that those impurities enter in and derange the circulation, are carried by that circulation through the lungs and there come in contact with the oxygen. These impurities are burned fiercely by that agent, the heat enters into the system—both the pulsation and the respiration are quickened, this increases the amount of oxygen, until the blood is almost made to boil, and the difficulty is increased until the disease is either checked or else terminates in death.

APPROPRIATE REMEDIES.

Now what are the appropriate remedies for this plus condition of the system? Why evidently minus, cooling substances. The acids should be freely administered, and such alteratives as shall remove the cause, uncap the closed pores, make the impurities exude again in their accustomed channels, and thus prevent the oxygen from burning up the system by its fierce ignition of those impurities in the lungs. Those internal remedies should evidently be always aided by such external applications as are calculated to accomplish the object, such as bathing, and friction with such volatile liquids as will evaporate rapidly and carry off the surplus caloric, which have the tendency to aid in producing perspiration.

CHAPTER XX.

ELECTRO-MAGNETISM.

Among other important designs, it is our object, in the present work, to prove the identity of all the imponderables. One very essential link in the chain of evidence will be furnished by the investigation of Electro-Magnetism. Until recently it was supposed to be an agent entirely distinct, and different from electricity. But it is now satisfactorily proven to be the same thing in essence.

HOW DISCOVERED.

This agent of nature was first discovered in a certain ore, found upon Mount Ida, in Asia Minor, by one **Magnes**, a shepherd, from whose name the word *magnetism* is derived. This ore is called, by mineralogists, *magnetic iron ore*, or in common parlance, the loadstone.

ITS WONDERFUL PROPERTIES.

The singular and wonderful powers which it exhibited in holding with considerable tenacity the various metals first led to its development. It was also, ascertained that it would not only exert an in-

visible and unaccountable influence over metals, but that it would impart to steel permanently, the same kind of mysterious influence.

No wonder that this ore was regarded by some, as a talismanic or a magic rock, in the earlier ages, when the idea prevailed to a considerable extent, that unearthly beings could throw their spells of enchantment around substances.

FURTHER DISCOVERIES.

It was next discovered, that if steel bars, which had been thus magnetised by the loadstone, were suspended at the centre by a thread or balanced upon a pivot, they would invariably arrange themselves north and south.

MARINER'S COMPASS.

This led to the invention, as is supposed, by Flavio da Melfi, a Neapolitan, in 1302, of that important instrument, called the Mariner's Compass, which opened a new era, in navigation. Mrs. Somerville, however, thinks different. She thus speaks in the following extract :

MRS. SOMERVILLE'S OPINION.

"The inventor of the mariner's compass, like most of the early benefactors of mankind, is unknown; it is even doubted which nation first made use of magnetic polarity to determine positions on the surface of the globe; but it is said that a rude form of the compass was invented in Upper Asia, and conveyed thence

by the Tartars to China, where the Jesuit missionaries found traces of this instrument, having been employed as a guide to land travellers, in very remote antiquity. From that the compass spread over the east, and was imported into Europe by the Crusaders, and its construction improved by an artist of Amalfi, on the coast of Calabria. It seems that the Romans and Chinese only employed eight cardinal divisions, which the Germans successively bisected till there were thirty-two, and gave the points the names which they still bear."

IMPORTANT TO NAVIGATION.

Before this auspicious event, the wary seamen cautiously coasted along the shore, and dared not venture far from land upon the ocean, where the foaming waste of waters seemed to him an impassable barrier. But the compass changed the whole scene. With it the mariner fearlessly spread his canvas to the breezes, although assured that they would quickly hurry him away from the sight of his native shores and mountains. Guided by his faithful magnet, he left the coast, to which he had formerly clung so timidly, "*far—far behind him,*" and sometimes held his onward course for weeks, and even months, through the wide waste of waters, without a glimpse of land to tell him where he was, and yet so perfect was that guidance, that, at any given moment, he could tell the latitude and longitude of the spot he occupied.

IMPORTANT EFFECT.

One important effect of that invention was the discovery of the happy country where we now dwell ; for, had it not been for the unerring guidance of the magnet, through calm and through storm, Columbus, notwithstanding his skill in navigation, and the dauntless intrepidity of his character, could never have found his way across the ocean from Europe to Hispaniola.

CAUSE OF MAGNETISM.

The *cause* of magnetism was, for centuries after its discovery, enveloped in inscrutable mystery. But, by the recent experiments and investigations of philosophers, that mystery has been satisfactorily solved. About sixty years ago it was ascertained by the celebrated Beccaria, and by our sagacious countryman, Dr. Franklin, that steel and iron could be rendered magnetic by Electricity. Since then, by the conclusive experiments of Professor Oersted, of Copenhagen, Professor Moll, of Utrecht, M. De la Rive, of Geneva, M. Arago, of Paris, Dr. Wollaston, Sir Humphrey Davy, Mr. Faraday, Dr. Herschel, Mr. Christie, and many other philosophers of Europe, together with those of Professor Henry, Dr. Hare, Professor Silliman, and others of our own country, it has been demonstrated beyond the shadow of a reasonable doubt, that all magnetism is produced by Electricity.

PROFESSOR OERSTED'S EXPERIMENT.

Professor Oersted, in 1819, found, that, by passing a **current of galvanism** around iron of a certain quality, **by means of insulated copper wire**, it was made **strongly magnetic**, and exhibited north and south polarity, **one extremity of the iron attracting the north point of the needle**, and the other south. It was, also, ascertained that by passing a galvanic current around steel in the same way, it could be made permanently magnetic, the same as if rubbed upon the loadstone.

OPINIONS OF MRS. SOMERVILLE.

In the language of Mrs. Somerville, "very delicate experiments have shown that all bodies are more or less susceptible of magnetism. Many of the gems give signs of it; cobalt, titanium, and nickel sometimes even possess the properties of attraction and repulsion: but the magnetic agency is most powerfully developed in iron, and in that particular ore of iron called the load-stone, which consists of the protoxide and the peroxide of iron, together with small portions of silica and alumina. A metal is often susceptible of magnetism if it only contains the 130,000th part of its weight of iron, a quantity too small to be detected by any mechanical test."

MAGNETISM BY FRICTION AND PERCUSSION.

"The bodies in question are naturally magnetic, but that property may be imparted by a variety of methods,

as by friction with magnetic bodies, or juxtaposition to them, but none is more simple than percussion. A bar of hard steel, held in the direction of the dip, will become a magnet on receiving a few smart blows with a hammer on its upper extremity ; and M. Hansteen has ascertained that every substance has magnetic poles when held in that position, whatever the materials may be of which it is composed."

It would be impossible, for the want of both time and room, to enter into a detail of the rise and progress of the science of magnetism, and trace the succession of various improvements made by the investigations of the learned. We must, therefore, content ourselves with a few brief remarks, in addition to what we have already said.

PROFESSOR HENRY'S EXPERIMENT.

A variety of experiments have been made by many of the learned, at different intervals, "but the most astonishing ever exhibited to the world in the production of magnetism by galvanic currents are those performed by Professor Henry and Dr. Ten Eyck, of Albany, in 1831. They constructed a horse-shoe magnet of Swedish iron, weighing sixty-nine and a half pounds, with an armature weighing twenty-three pounds. Around this magnet they wound twenty-six strands of copper bell wire, each thirty-one feet long, making eight hundred and six feet in the whole. About eighteen inches of the ends of the wire were

left projecting, so that the aggregate length of the coils was seven hundred and twenty-eight feet. On connecting the wires with a battery of 47-9ths square feet, the magnet supported two thousand and sixty-three pounds. In one experiment with a smaller battery, the armature continued to support more than one hundred and fifty pounds, three days after the battery had been excited.

INCREASE OF POWER.

From experiments already made, there seems to be no limit to the extent to which this wonderful power can be increased by the increase of the size of the magnet, and the increase of the number of coils of wire.

HOW VERY WONDERFUL.

How incomprehensible the force here exhibited—how disproportionate seems the cause to the effect. When the iron is bent and wrought into its proper form, and wound with the requisite quantity of copper coils, it will not suspend a single ounce of itself. But just send a stream of electricity or galvanism around those coils, and, with its poles suspended downwards, it can be made to sustain four or five thousand pounds, without any visible chain of connection to hold the ponderous mass, and without having its own weight increased a single perceptible particle. This immense load is sustained there by no

iron masses—no hempen cord—hung there apparently upon nothing tangible, visible or corporeal—sustained by the simple unaided ligaments of cohesive attraction.

PRODIGIOUS FORCE OF THIS AGENT.

Who, after witnessing such an exhibition of incomprehensible force, can doubt, for a moment, but that the powers of all other agents in nature are weak and impotent when compared with this. Who can doubt for a moment, but that, if its almost omnipotent energies could be harnessed appropriately to machinery by any invention, they would operate that machinery with a force as resistless as that exhibited by the bolt of heaven! Who can doubt but that its prodigious might is brought to bear upon the perfect machinery of the universe, and that it whirls the ponderous planets in their spheres, and hurls the comet blazing through its lightning course.

MAGNETIC MACHINES.

Not only have magnets of great power been produced by electricity, but, quite recently, a surprising motive power has been developed upon a small scale. Miniature magnetic machines have been constructed, which would rotate upon their axis with a prodigious velocity, varying from five to fifteen hundred revolutions per minute, that being from three to five times as rapid as any revolutions produced by steam.

TWO KINDS.

There have been invented two different kinds of electro-magnetic machines, the one operated by simple attraction, or by the influence of iron alternately magnetized and demagnetized by alternately breaking and closing the galvanic circuit, as it is called, and the other by attraction and repulsion, or a change of polarity, which is effected by such an arrangement that the galvanic current circulates half the time around the magnet in one direction and the other half in an opposite direction, whereby the poles of the magnet change alternately from south to north, and from north to south, the polarity of the magnet being dependent upon the direction of the galvanic current around it.

VIBRATION PRODUCED.

Motion was produced, in 1830, by means of a galvanic magnet, constructed by Professor Henry, and so arranged, that it caused a beam suspended by its centre, to vibrate like the walking beam of a steam engine. Taking an idea from this invention of Henry's, similar machinery was constructed in Europe. Mr. McGauly, of Ireland, reported, in 1835, a galvanic machine to the British Association, and Mr. Sturgeon, of Woolwich, in England, gave a description, about the same time, of one, which he used upon his premises for pumping water and for other mechanical purposes.

CHAPTER XXI.

ROTATING ARMATURES.

ROTARY motion was first produced by Dr. Edmonson, of Baltimore. In 1833 or 1834, he constructed a very simple, but yet a very beautiful electro-magnetic machine, called *Edmonson's rotating armatures*, which was composed of a brass wheel, containing a small brass hub and an axle about four or five inches long, with six spokes of brass wire, an eighth of an inch in diameter, and six inches long, with soft iron armatures, composed of wire a quarter of an inch in diameter and two inches long, screwed upon the ends of the spokes, and arranged parallel with the axle.

Through two brass pillars on each side of the wheel, which was horizontal, passed two screws which formed pivots, upon which the wheel could revolve lightly and without much friction. At a little distance from one end of the axle was screwed a brass plate disc, about three inches in diameter, and, at the same distance from the other end, a serrated disc, containing as many points as there were spokes and armatures. These revolved in cups arranged underneath, containing mercury.

On the outside of the whole was placed a single

electro-magnet of small size, which, when charged with a small battery, would attract the soft iron armatures successively toward itself, until they came to the point where it would hold the iron and prevent motion, were it not so arranged that the movement of the wheel would demagnetize the magnet, by lifting the point of the serrated disc out of the cup of mercury, and thus by breaking the circuit explode the magnetism in a brilliant galvanic spark and let the armature pass by. This wheel could be made to revolve from three to five hundred revolutions per minute.

INVENTOR OF ROTARY MOTION.

Although it has been generally supposed that Davenport first produced rotary motion by means of magnetism, yet this honor, as we have shown, belongs to another, who invented his rotating armatures about three years before Mr. Davenport perfected his electro-magnetic machines.

ATTRACTION AND REPULSION.

These rotating armatures of Edmonson are moved by simple attraction. But to Davenport belongs, however, the exclusive honor of inventing a machine moved by alternate attraction and repulsion, which, for a time, astonished the whole scientific world, and inspired the general belief, that the power of electro-magnetism was about to be brought to bear upon machinery.

A brief detail of the several stages of progression, by which Davenport perfected his invention, and discovered truths which had for ages eluded the keensightedness of the scientific, would doubtless be interesting to those who are unacquainted with the facts.

MR. THOMAS DAVENPORT.

Mr. Thomas Davenport was an unlettered blacksmith, of Brandon, Rutland county, Vermont. In the course of his trade, he went, in 1833, to the Penfield iron-works, at Crown Point, on Lake Champlain, to purchase iron. His curiosity was there very much excited by the operation of a revolving machine with several hundred magnetized steel points or teeth, which passed through pulverized ore, to separate the particles of iron from the surrounding material. Finding upon inquiry, that these points were magnetized by a small electro-magnet weighing about four pounds, he inquired the price of the apparatus, and, instead of purchasing iron as he contemplated, he expended his money for the magnet, and took it home.

Filled with that kind of enthusiasm which completely absorbs some minds, and which appears superlative folly and mental hallucination to those dull phlegmatics who always plod along in the beaten path of grandfathers and great-grandfathers, he commenced a series of experiments with his magnet, assuring his neighbors and friends that it was his firm belief that this power could be made to propel the largest boats.

Although this announcement was received by them with general incredulity and ridicule, and although he had to encounter every discouragement on account of deficiency in his pecuniary resources and the continual dissuasion of his acquaintances, he pressed forward with a commendable and indomitable perseverance toward the accomplishment of his object.

INDEPENDENT MINDS.

It is proved by all history, that a mind which is truly inventive, and capable of conceiving grand projects, has the dignity to rise above the influence of both sneers and dissuasions, and to accomplish such projects, if they be within the range of possibility. Such was the mind of Thomas Davenport. He was neither discouraged nor disappointed by the reception he experienced. "He thought and reasoned for himself; and, relinquishing his trade, he devoted his undivided attention to the object in view. After trying hundreds of experiments, and devoting several months to an intensity of reflection which would have brought many others to a lunatic asylum, he finally, in July, 1834, accomplished the arduous task of bringing the invisible and mysterious power of magnetism into subjection. A power which, 'steady as the needle to the pole,' had been thought the most unyielding of all others; forming an arrangement by which this very polarity, this steadiness of purpose, is made to produce rotary motion."

DAVENPORT'S SUCCESS.

After encountering many hindrances, Davenport perfected, so far as it was possible to perfect, his miniature machines, so that they would revolve with almost inconceivable velocity. They consisted, sometimes, of both stationary and revolving magnets, so arranged that, by their movements, the polarity of the magnets would instantaneously change at a certain point, and thus the machines would be alternately propelled by attraction and repulsion, resulting from a change of that polarity.

As it would, by mere language, without the apparatus, be impossible to give such a description of the machinery as to convey a clear idea of the precise manner of its arrangement (by which polarity is changed during revolution) to the minds of those who have never seen it operate, and as it would be unnecessary to give such a description for the satisfaction of those who have seen it operate, we shall omit it altogether.

DIFFICULTY ENCOUNTERED.

After having perfected his machines upon a small scale, so that they performed admirably, he proceeded to construct one upon a larger scale, for the purpose of acquiring power, if possible. But, in this experiment he was unsuccessful, and the persevering originator of a wonderful invention has passed into obscurity

again, like a flashing meteor, and is now almost forgotten. •

CAUSE OF THAT DIFFICULTY.

When he proceeded to enlarge his machinery, he met with an unexpected and insurmountable difficulty, in the impossibility of so nicely arranging it, that the polarity would change perfectly, at the proper point and time, and the one force give place completely to the other. There would, on the contrary, be at that point a contention between the two powers of attraction and repulsion, which contention would neutralize the power of the two, and bring the machine to a stand.

OUR INVENTION.

While investigating, in 1838, this interesting subject, we were satisfied that machines operated by a change of polarity could never be anything but mere philosophical toys, interesting and wonderful, but entirely useless. It occurred to us, however, that the difficulty could be obviated by machines operated by simple attraction, provided that there could be an arrangement made by which the power could be kept up without intermission. This we effected by bringing a series of magnets to bear upon the same wheel in such a manner that, by means of non-conductors between the serrated discs, by which the galvanic circuit was broken, one circle of the series should be

charged while another was demagnetized, and so the power continued without intermission.

SUCCESSFUL.

Having been quite successful in the first model constructed, we sent a description of the same to the Patent Office at Washington in 1838, designing at the time to have taken out a patent, and to have tested the invention upon a large scale, but other engagements have prevented the contemplated experiment.

IMPORTANT QUERY.

As far as this mysterious and wonderful motive power has been applied, it can be regarded only as a most interesting philosophical toy. But the question here occurs—can it be applied to any practical purpose—can machinery upon a large scale, where great resistance is to be overcome, be propelled by it? This remains to be proven. We are not prepared to say that it *cannot*, nor are we prepared to say that it *can*. Of one thing we have a practical demonstration—it operates well upon a small scale, and exhibits considerable force; whether it will upon a large scale depends upon the developments of futurity.

ROTARY MOTION BY STEAM.

Rotary motion was produced by steam *fifty years* before it was applied to any practical or useful pur-

pose. Its miniature machinery was then looked upon as an interesting philosophical plaything—as electro-magnetic machinery now is. It has been only about twenty years since the motive power of magnetism on a small scale was developed, and it would be forming a conclusion with more dogmatic positiveness than we are willing to form one, to hazard the assertion that locomotives may not, within fifty, nay, within twenty years, be driven with lightning speed over our railroads by magnetism, and the electricboat, instead of the steamboat, be propelled across the Atlantic. There are a thousand improvements yet to be made, which have not even been *dreamed* of by the most acute philosophers. Some Davenport may even now be perfecting machinery which may, by its successful operation, astonish the world as much as the motive power of magnetism did when first developed. There is certainly no lack of energy in the agent. Its inherent force surpasses steam, or any other natural agent. There is a superabundance of power, as is demonstrated by the magnet of Professor Henry. Its correct application is all that is needed, and we are by no means prepared to say that such an application cannot be made. From what we have seen, we are rather inclined to believe that it can, and that it will, although the person who is hardy enough to persevere may encounter as many sneers as the immortal Robert Fulton did, before he succeeded in applying steam power to navigation.

PRACTICAL IMPROVEMENTS.

If this subtle and wondrous agent has not yet been harnessed for practical use, and applied to the propulsion of the vessel and locomotive, yet it has been made very usefully subservient to the welfare of man in other respects.

THE TELEGRAPH.

By means of an arrangement of galvanic batteries, electro-magnetic machines, and a series of conducting wires, messages are now sent with the speed of lightning all over the land, and will soon be all over the *world*. The whole civilized globe is at this moment (July 27th, 1858) on the tiptoe of expectation, awaiting the result of the attempt to lay the Atlantic cable, intended to form an electric communication between two continents.

If that magnificent enterprise fails, as it may, yet the two continents *will*, at some time not far distant, *be certainly connected*. A line will be constructed up the Pacific coast, across Behring's Straits, and through Asia to Europe and Africa. When that is constructed, we can get messages at any time from the most distant extremities of our globe in *five minutes*.

Some one of Shakespeare's characters proposed to "put a girdle round the earth in forty minutes." Rodomontade as it was then regarded, he was a slow stager, and behind the age compared with Professor Morse, who, by means of his immortal invention,

can belt the earth with lightning in less than five minutes, and, with suitable arrangements, even in less than ONE minute.

BENEFIT TO DENTAL SURGERY.

Dr. Francis, of Philadelphia, has invented an application of electro-magnetism to the extraction of teeth, in such a manner as to prevent pain, and enable dentists thus to dispense with the dangerous use of chloroform.

MAGNETO-ELECTRIC SHOCKS.

We will close this chapter by remarking, that our object is to prove the identity of all the imponderables, and that they are electricity. Magnetism aids materially to demonstrate this, from the fact that a galvanic current will make a magnet, and out of magnets can be drawn both electric sparks and electric shocks, as in the operation of the magneto-electric machine—shocks as severe, and sparks as brilliant as from the Leyden jar.

CHAPTER XXII.

LIGHT.

HAVING examined the subject of common Electricity, Galvanism, Magnetism, and other kindred subjects, and proved their identity, and demonstrated that this indivisible, imponderable principle is the wondrous agent, by which *all chemical changes* are effected, we shall now endeavor, by a formidable array of facts, and by conclusions drawn legitimately from them, to prove that the sun is the SOURCE of this agent. This will require us, in the first place, to investigate the properties of *Solar Light*.

SOURCE OF ALL LIGHT.

This, it is evident, is to be regarded as the fountain from which continually flows all natural light, for, it will appear conclusively in the course of our observations, that it would be utterly impossible to produce fire were it not for the existence of this agent. And here an interesting question respecting its nature and essential properties forcibly suggests itself to the mind: What is that light? It seems to be a subtle, ethereal, all pervading fluid. No sooner does it glance upon a substance than it is gone. Suddenly darkens a

room into which a strong flood of light is pouring, and it is all dissipated as instantaneously as thought. Not a solitary ray is left to illuminate the darkness. Blow out a candle, whose light can be seen by the eye, at any point for a mile in every direction around it, and which, therefore, completely fills several cubic miles of space, and not the minutest iota of time does that light continue, after the candle is extinguished.

A thunder bolt blazes across the black canopy of a midnight storm, and its scathing light fills perhaps a thousand cubic miles of space. Blinded by the intense and lurid glare, the eye of the beholder shuts for an instant, and opens—upon what? A darkness deeper, if possible, by contrast, than before. The lurid flash has gone. Where? Is it annihilated? No. It is somewhere in a state of diffusion, and consequent invisibility, and if collected under the same circumstances, it would exhibit the same flash as before, and again diffuse itself through the mass of surrounding substances. Light then, as we have already remarked, is subtle, ethereal, and all-pervading.

IMPONDERABLE.

It is imponderable too, that is, it can be neither weighed nor measured. When a ponderable substance of several tons bulk, is completely saturated with it, the specific gravity of that substance is not increased the smallest perceptible particle!

ITS MOTION RAPID AND CEASELESS.

Never, for an instant, is this subtle agent stationary. The lightning speed of its everlasting career can be compared with no other agent in nature except Electricity. It glances quick as thought from heaven to earth—from the sun to the planets.

DR. HERSCHEL'S THEORY.

There are two theories respecting the essentiality of light, both of which will, for a moment, be examined. Dr. Herschel and his coadjutors supposed that it was the effect of the undulation or vibration of a subtle, ethereal medium everywhere present in nature, and that it is transmitted to the eye the same as sound is to the ear. Upon this hypothesis there would be no direct communication between the sun and the earth, or the other attendant planets, and this being the case, the generally received opinion among philosophers, that the movements of the planets are governed by a certain kind of influence exerted by the sun over them, would be erroneous ; for we hold it to be a truth capable of the clearest and most logical demonstration, that there cannot be any influence exerted by one substance over another, without a direct and positive connection, of some sort between those two substances. To suppose the contrary, would be to suppose that there is a connection and that there is not a connection in the same breath, which is a self-evident contradiction in terms.

We hold such an influence, without such an actual connection, to be an impossibility in the nature of things, which, to speak reverentially, not even omnipotence can overcome, for God himself never claims to do that which is an impossibility in the nature of things.

But it may be said that the Almighty created the universe with a word, and that there is no positive connection between a mere word and such a stupendous effect. True, but if he created that universe with a word, his all-pervading Omnipotence was present to give that word efficiency ; for to suppose the contrary, would be to suppose that God can withdraw himself from a positive connection with his own agencies, which is another self-evident contradiction, unless you can undeify the Deity and make infinity finite.

THIS THEORY UNPHILOSOPHICAL

Besides, the opinions of Dr. Herschel upon this subject are unphilosophical and contrary to known facts. Instead of undulating or vibrating, light moves in direct lines. This is capable of positive proof. The angle of incidence and that of reflection are the same. Let a stream of light fall upon a mirror at a particular angle, and it will be reflected from that mirror in an exactly opposite angle. It is a tested and acknowledged fact also, that light will not pass through a bent tube. But if it moved in undulations or vibrations like sound, this would not be the case, for sound will pass through such a tube. These facts and argu-

ments, therefore, prove that the hypothesis of Dr. Herschel, respecting light, is false and unphilosophical.

NEWTON'S THEORY.

The other theory of which we spoke, is that of Sir Isaac Newton. It was the opinion of that great philosopher, that solar light is an infinitesimal effluvia of matter or an emanation of inconceivably minute particles flying off from the body of the sun, and darting in straight lines through that space which is occupied by those opaque bodies which are governed by its influences.

THIS HYPOTHESIS CORRECT.

This hypothesis we consider to be correct and philosophical, if we regard it as an emanation of matter, different in its nature and essential properties from ponderable, inert matter—if we regard it as an imponderable essence, as it doubtless is, governed by the very same laws, and exerting precisely the same agencies as the other imponderables, which we have already examined.

SOME THINGS UNEXPLAINED.

Newton, however, left some things unexplained in his theory of solar emanation, which, unless satisfactorily accounted for would involve the subject in an inexplicable difficulty. Although he maintained the opinion that light was constituted by a flight of particles from the sun, and thus far was doubtless correct,

yet he failed to account for the supply of that waste of the substance of the sun, which must unavoidably be the consequence.

The objector to his theory, who might wish to puzzle the philosopher, might put the question, "If light be an emanation of infinitesimal atoms or particles of matter from the orb of day, why is it not diminished—why not exhausted and blotted out?" And such a question too would be a very natural one, and deserving of attentive consideration. Light is constantly emanating from the sun. This is a known and a generally acknowledged fact in science. Every conceivable point of space for ninety-five millions of miles around that luminary, or to the orbit of our earth, and so around the whole circumference of that orbit is constantly filled with light; and as light is estimated to move from the sun to the earth in eight minutes, then this whole entire ocean of light, one hundred and eighty millions of miles in diameter, and nearly five hundred and forty millions of miles in circumference, containing billions upon billions of cubic miles of light diffused over space, is displaced every eight minutes by a new emanation—a fresh ocean of light, and that by the flood-tides of another ocean, and that by another, and so on to infinity.

Nor is this all. The whole space between us and the far off orb of Herschel is thus constantly filled with light, and that light is thus constantly displaced by wave succeeding wave in endless succession.

THE WASTE MUST BE SUPPLIED

Now the idea that this is matter which is thus passing off from the sun with the glance of the lightning-flash, and filling every eight minutes an almost inconceivable area of space, would be preposterous in the extreme, unless there were, by some process of nature, an adequate supply for such an immense and unavoidable waste. This conclusion is in strict accordance with every principle of philosophy, analogy and fact. It is perfectly evident that particles flying off from a body must inevitably diminish that body. No matter how infinitesimally minute those particles, nor how immensely large the substance, this must be the case so long as the smallest atom of matter conceivable possesses both length, breadth and thickness.

OTHERWISE THE SUN MUST PERISH.

It can, then, be mathematically demonstrated, as perfectly as any problem of Euclid ever was, that the sun, unsupplied from some source, would, long since, have been frittered away by infinitesimal abstractions, and been utterly annihilated by this waste, even though we should, for the sake of argument, adopt the supposition that a million of cubic acres of those particles, when condensed sufficiently, should weigh no more than the ten thousandth part of a single grain; for, however vast the waste be the space, such a diminution of matter by the loss of particles would be the same as the loss of a grain of sand from a mountain.

cles so immense as to fill a cubic bulk of space one hundred and eighty millions of miles in diameter, and nearly five hundred and forty millions of miles in circumference every eight minutes, must certainly annihilate that substance completely in process of time. As "a continual dropping wears away the solid rock," so a continual waste must eventually exhaust—completely and utterly exhaust even the bulkiest mass conceivable.

IMPORTANT QUERY.

If light, then, be the emanation of infinitesimal effluvia from the sun, as it doubtless is, how shall we rescue the Newtonian theory from the difficulties in which it seems to be involved? We must suppose either that there is, somehow, an unseen and imperceptible return of those particles, to the source from whence they emanated, or that that great fount of light is constantly fed by creative agency constantly exerted, or else, as the horrid alternative, that the world would long since have realized the terrific phantasies of Byron's poetic dream on darkness, when

"The bright sun was extinguished, and the stars
Did wander darkling in the eternal space,
Rayless and pathless, and the icy earth
Swung blind and blackening in the moonless air."

The latter alternative, we know, however, has not been taken place, and the proposition, that the waste is supplied by direct creative agency, is contrary to all

analogies of divine economy. When the Almighty created the universe, he created, also, it is presumed, all the natural laws and agencies by which that universe should be governed, until the present order of things shall be broken up by the same Omnipotent word and energy which established it and,

"Final ruin fiercely drive her ploughshare o'er creation."

CREATION COMPLETED.

He did not leave his work half done. He completed creation—he pronounced the whole good, very good, and on the seventh day he rested from his labor. It cannot be presumed that the process of creating new materials to supply any deficiency in this splendid machinery of worlds is now progressing. The supposition would be derogatory to the skill of the great architect. It would be contrary to the analogy of all his doings.

CONTINUED MUTATION BUT NOT CREATION.

Although there are continual changes going forward in the materials of which this globe and its surrounding atmosphere is constructed—although there be a ceaseless progression of chemical decomposition and recomposition among various substances — although what was a tree one year, may, by transformation, become grass the next—or what was grass one day may become either flesh or milk or cheese or butter the

next—or what was fish in one age may be petrified into limestone the next, and, instead of floating in the water, become the material with which your parlors are plastered, yet, it is presumed, that not a single new particle has been added to the globe or its varied furniture since creation, however modified it may have been, either by nature or art.

One might imagine, perhaps, that, in the combustion of fuel, there is some destruction of material. But such is not the fact. It has only undergone a change. Every particle of it exists some where either in vapor or smoke or the gases or in ashes. And so with every thing else. When the streams dry up in the season of drouth, there is not a drop the less water than before. It is either in the deep well-springs of the earth, or is borne about in the vapors of the atmosphere, nor is there a drop more when the streams are full, nor was there, when the windows of heaven were opened, and the fountains of the great deep were broken up, and the deluge covered fifteen fathoms deep, the tops of the highest mountains. It was either spouted up from the subterraneous reservoirs of earth, or the surrounding atmosphere, which extends forty five miles above the globe gave out its watery treasures, or the melted icebergs came down in torrents from the arctic and antarctic seas.

CHAPTER XXIII.

LOGICAL INFERENCE.

FROM these analogies, and a thousand others unmentioned, we infer that no creation of material is progressing to supply the waste of the sun. Shall we then resort to the other hypothesis, that the otherwise unavoidable diminution of the sun is supplied by the return, through some channel, of those same particles, which have accomplished the object of their mission? Let us see what testimony analogy furnishes upon this important subject, before we hazard an answer.

THE HUMAN HEART.

The human body affords a good illustration. The heart sends out the vital stream by successive pulsations, through its purple channels, to the extremities, of the system, and is, in its turn, supplied by that same blood, which it sent out in its passage back through the little veins, to be again projected by the self moved action of the wondrous machine.

THE OCEAN.

The waters of the globe afford another very good illustration. The ocean is, as it were, the heart of the

earth. By evaporation it supplies the clouds with water, this is borne over the globe and discharged among the mountainous regions, to supply the high lakes and fountains. These send forth the little rills and streams, which, uniting in their course, form rivers, which empty into the ocean again, and keep that immense reservoir unexhausted.

INFERENCES.

Now, what the heart is to the human body, or the ocean to the globe, we conceive the sun to be to the solar system. By its mighty pulsations, it sends out its living stream to vitalize and energize creation, and when one pulsation has done its work, and given its share of the mantling blush of health to the cheek of beauty, and of luxuriance to the verdure of vegetation, and of varied tints to the flower, and of ripeness to the mellow fruits, and of motion to the planets, it speeds on in its lightning circuit, and gives place to another pulsation, and thus pulsation after pulsation chase each other in one interminable and ceaseless round, supplying by some inexplicable method of return, the waste which must otherwise accrue.

MATERIALITY OF LIGHT.

We have considered the Newtonian theory of the materiality of light as correct, though not matter in the common acceptation of the term, for it is totally different from any tangible, appreciable form of mat-

ter with which we are acquainted—being imponderable, and immeasurable, passing through transparent mediums without seeming to encounter any obstacle—entering readily into the eye, the tenderest and most delicate organ, without causing pain or being perceptible in its passage.

EXTRACT FROM FERGUSON.

The following appropriate extract from Ferguson's *Astronomy* will forcibly illustrate the extreme subtlety and imponderability of this agent. "Light consists of exceeding small particles of matter issuing from a luminous body ; as from a lighted candle such particles of matter constantly flow in all directions. Dr. Niewentyt* computes that, in one second of time, there flows 418,660,000,000,000,000,000,000,000,000,000,000,000 particles of light out of a burning candle, which number contains at least 6,337,242,000,000 times the number of grains of sand in the whole earth, supposing 100 grains of sand to be equal in length to an inch, and consequently every cubic inch of the earth to contain one million of such grains."

STARTLING CONCLUSIONS.

These amazingly small particles, by striking upon our eyes, excite in our minds the idea of light ; and if they were as large as the smallest particles of matter discernible by our best microscopes, instead of being

* Religious Philosopher, Vol. III., p. 65.

serviceable to us, they would soon deprive us of sight by the force arising from their immense velocity, which is 164,000 miles every second, or 1,230,000 times swifter than the motion of a cannon-bullet ; and therefore, if the particles of light were so large, that a million of them were equal in bulk to an ordinary grain of sand, we durst no more open our eyes to the light, than suffer sand to be shot point blank against them.

SIMILARITY OF LIGHT AND ELECTRICITY.

Now, with respect to extreme subtlety, does not light resemble electricity ? Is there any other agent in nature, which will pass thus through the eye without affecting it except electricity, for that will thus pass ? Let a pointed rod be connected with an electric machine, and a stream projected through the eye from that point will cause no more pain than light, though differently modified. And if light be electricity, there would then be an additional argument in favor of the supposition, that emanations of this fluid return again to their source, the sun, as all electricity, however modified, moves in a circuit, and exhibits no effect except the circuit is closed.

NOVEL BUT NOT CHIMERICAL

This is doubtless a novel idea, and may, for that reason alone, be considered, at first thought, chimerical and baseless. But we only ask calm reflection

upon the subject, and candid attention to it; for, we are persuaded, that, after mature consideration, it will not appear so visionary, as may, at first glance, be supposed. If it perform a circuit, it must be so immense as to be almost beyond computation.

ILLUSTRATION.

To illustrate this subject, trace a single ray, for instance, in its passage from the sun, out into space, for millions upon millions of miles, and there would be a point in its outward passage, and its consequent continual divergence, that the ultimate particles which constitute that ray must of necessity begin to separate from each other. Now, when they come to that point of incipient separation, what becomes of them? If they make a complete circuit, as we believe they do, the ultimate particles which composed the ray would, when they began to separate (if they have the same organic laws as electricity, which we shall prove), present their negative or minus polarity toward the sun, and in that separated state they would be drawn back to their source by the simple laws of the attraction of opposite polarities, which we have already abundantly demonstrated.

AN OBJECTION ANSWERED.

But it may be affirmed that, as light moves in straight lines, one part of our theory clashes with another, since, according to this view of the subject, it must move in

curved lines. This apparent clashing, however, is very easily explained, and this objection readily obviated. So inconceivably immense is that orbit which is described by a ray, that, although it is *actually* circular, yet any perceptible part of the orbit which it describes would appear to be *straight* to us, and thus there would be no clashing between the two positions in reality.

It would be very easy, we are aware, for a fruitful imagination to invent objections, but before our theory is confidently and positively denied, we would ask those who would invent such objections to tell us what becomes of light, if it does not thus move in a circuit and thus return to its source. Is it annihilated, or does it become stagnated and dormant, and lose its inherent activity in the vast abyss of space? And if it move not thus, and return, we would ask those who invent such objections, if they are prepared, in any other plausible or rational way, to account for the otherwise unavoidable waste of the material of the sun. If they can, we will willingly become learners, and will pledge ourselves to give up all prepossessions in favor of any opinion which we may have harbored. But if they cannot, they are bound, we think, to consider well the propriety of making objections upon a subject when they know not positively whether their objections are well founded. Firmly believing, however, that they cannot, we shall, for the present at

**adhere to the conclusions to which we have
me.**

CONCLUSION.

Light, then, doubtless, after having performed its office, returns to its fountain in some mysterious, perhaps inexplicable manner, and thus closes its circuit. Else, what, I ask, becomes of it? Has the earth, for instance, drank in and retained all the light which has been shed upon it by the sun since creation? If it had, we conceive it to be a proposition capable of the clearest demonstration, that it would have been, by this time, a complete ball of light, like the sun.

Besides, had it retained all the rays which have fallen upon it since the morning of time, its bulk, ere this, would have been very sensibly increased; for, although light be imponderable, yet it is *something*, and is capable of accumulation, like other matter, if retained. Not only would the earth be increased by this accumulation, but every planet of the solar system and the sun, as every one must see, would be proportionably diminished. And what would be the consequence of such a diminution of the one, and increase of the others? Why, the perfect balance of the system, which produces such a wonderful regularity of revolution, that eclipses can be foretold for years before their occurrence, to the definiteness of a single moment, would be entirely destroyed, and the whole would rush headlong to the confusion and darkness of chaos. Neither the earth, therefore, nor the other bodies of the solar system, have retained the light

which has fallen upon them, but having been as completely saturated the first twenty-four hours of their existence as ever, they have thrown off all superabundance, the same as substances do, when surcharged with electricity.

We have dwelt upon this subject of the return of particles to the sun with the more minuteness, because, if true, it may account satisfactorily for an important phenomenon, to which we shall have occasion to advert hereafter.

We shall defer until our next chapter, the further consideration of this important and interesting subject, and hope, by still further argument and proof, to demonstrate the correctness of our position.

CHAPTER XXIV.

IDENTITY OF LIGHT AND ELECTRICITY.

THE commencement of the present chapter will be the continuation of the subject of the identity of solar light and electricity. In the discussion of the subject, such a chain of proof will, we think, be linked together, as to be conclusive and irresistibly convincing.

ACCUMULATION OF PROOF.

As the correctness of our theory depends mainly upon the demonstration of the preposition that light is electricity, we will proceed in the examination of proofs.

The two possess many properties in common. Light, generally speaking, is attended with heat—so is electricity. Light has inconceivable rapidity of motion—so has electricity. The one is imponderable, immeasurable, all-pervading—equally so is the other. And what if they do vary in some of their appearances—vary in some of their effects and operations? Does that circumstance necessarily destroy their identity—their oneness in principle or essence? Certainly not. Known and acknowledged electricities thus vary, and that, too, quite as widely. The spark and the shock of the electric machines are somewhat different from

the galvanic current. The meteoric shower is different from the keen flash and fierce energy of the bursting thunderbolt. The blaze of the thunderbolt is different from the mysterious corruscations of the Aurora Borealis and Aurora Australis, and these again are all different from magnetism or magneto-electricity. Even the very same galvanic current, when modified by machinery, as can be demonstrated with a piece of apparatus, is different under one set of circumstances, from what it is under another.

ILLUSTRATION.

If a person take hold of the poles of a small battery, and close the circuit, he receives no shock. But pass that same current around a helix of copper wire, enclosing soft iron, and forming what is called the magneto-electric machine, and then, by the action of the machine, a person receives shocks whenever he closes the circuit, by taking hold of tin tubes having a connection by conducting wires with the positive and negative poles of the helix.

CONCLUSION.

This proves *conclusively* that dissimilarity in appearance or in action destroy not identity in essence. This dissimilarity depends on modification and on that alone, the causes of which are sometimes apparent, and sometimes latent. The want, then, of resemblance in any respect between light and electricity, destroys not

necessarily their identity. And even on the score of similarity, they are, by no means, materially deficient. There are, in fact, more points of marked resemblance between them than between many known and acknowledged electricities—more, for instance, than between the Aurora Borealis and magnetism. And were the attention of philosophers turned to the investigation of these phenomena with all that intensity, which its importance demands, we are persuaded that more resemblance would be discovered. Who can tell, but that, some day, an immense number of these rays could be brought into one line of light, as they are brought to a focus by the lens or burning glass, and could they be continued onward in that line, without being scattered—who can tell, we say, but that this condensation of rays might be one continual stream of fire like that of the electric fluid?

PROPOSED EXPERIMENT.

Although we have never actually tried the experiment, for the want of suitable facilities, yet we are confident in the belief that, if a large number of rays could be collected by an immense convex lens of a suitable shape, and if a good conducting rod could receive them just at the focal intensity of their concentration, very powerful electrical manifestations would be produced. Let those who have suitable apparatus solve the problem, for it is certainly worthy of a solution.

But a truce to supposition. We need not resort to hypothesis or conjectures to establish the plausibility, or even the logical *certainty* of our argument. We appeal to facts—*incontrovertible* facts, to prove that light is electricity. These facts we shall glean from observations of practical men, which are preferable to any philosophical surmises or fine spun speculations.

JOHNSON'S OBSERVATIONS.

Lieutenant Johnson, of the British navy, often noticed that a considerable variation of the needle of the compass was produced by the rays of the sun falling upon the glass which covers it.

TESTIMONY OF HARRIS.

In support of this testimony, I have that of Mr. Harris, a resident of Ravenna, Portage county, Ohio, who had been a surveyor at the West more than twenty years, and who had often been engaged in running lines.

In the commencement of his business, he was often much troubled by the variation of the needle, and imputed it, at first, to the vicinity of iron ore, which is the popular solution generally given for such phenomena. But he noticed, after a while, that those variations occurred in a cloudless day, and just about noon, when the sun was vortical. The idea occurred to him that it might be electricity, produced upon the glass cover by the sun's rays. In order to test the correctness

of that idea, when such variations occurred, he moistened the glass so as to dissipate the electricity, and found by so doing that the variation was instantly prevented. Since that, he affirms that he has been no more troubled with the supposed attraction of metallic substances, and his remedy is an infallible preventive of the variations that so much troubled him.

Since we first commenced the particular investigation of this subject, in 1838, we have had frequent opportunities to consult the oldest and most observing practical surveyors, and they have, without any exception, in every instance, corroborated the statements of Mr. Harris and Lieutenant Johnson. One whose name, for particular considerations, we shall omit, but who was as good authority, probably, as any one we have consulted, not only testified his firm belief in the cause assigned by Mr. Harris, but suggested the thought that both diurnal and annual variations of the needle might possibly be determined by the variations even of the thermometer. He had noticed that there was, owing to this cause, a gradually *increasing* variation from eight o'clock, A. M. till noon, when the sun was cloudless, and as gradual a *decreasing* variation from noon till four or five P. M.

OBJECTION ANSWERED.

But some may, perhaps, be willing to acknowledge the premises, from which we started, but deny the validity of our conclusions. They may assent to the

Proposition that electricity causes such variations of the needle as we have been contemplating, and that that electricity may be produced by the mere friction of the sun's rays upon the glass cover of the compass, but that it cannot be the sunlight itself.

This, however, would be an assumption altogether unreasonable and unphilosophical. Even if produced by the friction of the rays (which cannot be the case, since light passes so readily through a transparent medium, without friction) either the light or the glass must give out the electricity, for, in all cases where electricity is developed by friction, either the rubber or substance rubbed produces it. The one substance that affects the other is, uniformly, the substance that is the generating agent. Even if light, then, produces electricity by friction upon the cover, it, after all, develops it from its own substance, and so nothing is gained by the objector, nor are our conclusions at all impaired.

MRS. SOMERVILLE'S EXPERIMENTS.

In addition to these facts, which are of themselves sufficient to demonstrate that light is electricity, it has been ascertained by the celebrated Mrs. Somerville, of England, that by passing the sun's rays through a prism, and separating them, by analyzation, into the seven primitive colors, the blue color possesses the power of imparting magnetism or polarity to the

needle, and *magnetism* we now know to be electricity, by experiments too conclusive to be controverted.

AN IMPORTANT FACT.

There is another very important fact respecting the organic laws of the constitution of both light and electricity which furnish additional and weighty testimony in favor of identity. The attractions of electricity decrease in exact proportion as the squares of the distance increase, in receding from an electrified body. This is precisely (as we should suppose) the law of the divergence of light, and this law, which runs throughout all the imponderables, has its origin in the law of solar emanation or divergence, and the simple reason why the attraction of all bodies decreases in proportion as the squares of the distance increase, is because the emanating influence of all bodies which constitutes attraction obeys this law.

CONCLUSIVE TESTIMONY.

The very strongest testimony, however, in proof of our proposition is contained in the phenomena of the polarization of light, by which it is *demonstrated*, that every particle of light, as well as of electricity, *has opposite polarities*.

By a fair logical deduction, then, with facts amply to sustain it, we unhesitatingly infer that *light is electricity*.



CHAPTER XXV.

CALORIC.

HEAT, or caloric, comes next in the order of remark, and in the investigation of this subject we shall accumulate such an additional array of facts as shall establish our proposition beyond the shadow of a doubt.

SAME ARGUMENTS VALID.

The same arguments which would prove that light is an electric agent are applicable also to the agent of heat. Heat like light is imponderable, subtle, ethereal and all-prevading. No obstacle can stay its *passage*; it insinuates itself between the particles of the densest bodies as though it were immaterial; its power is prodigious—irresistible in its energies; it generates the tremendous power that propels the steamboat, and were it, or could it by any means be confined in subterraneous volcanic caverns, with bands strong enough, and there accumulated, it would, by the power of its expansive and explosive force, burst the solid globe to atoms, and send its shattered fragments in every direction through the vacuum that surrounds it.

AN EXPERIMENT.

With a glass bulb and tube, for instance, one of the energies of heat can be forcibly demonstrated. By inverting it, and inserting the open end in a basin of water in its natural state, you will perceive no effect whatever; but by passing into the tube the subtle agent of caloric from a spirit lamp and again inverting it, you will see the water rise with great rapidity, and fill more than nineteen-twentieths of the tube. This shows that heat has the power to expel the atmosphere and occupy its stead. But the moment you attempt to confine it there, by closing the tube, it is gone like a flash—gone like a viewless, incorporeal, intangible thing, and the water rushes up to fill that vacuum.

INFERENCE.

If all the imponderables, as we have assumed, be identical, then Light and Heat are the same—they co-exist and are inseparable. But, it may occur to some one, that those phosphorescent substances which emit light, do not, also, emit heat, and that our position is, therefore, untenable. This conclusion is, however, altogether too hastily formed. It will be seen, by the following lucid extract from Turner, that heat is *always* necessary to make substances phosphorescent.

CHEMICAL AGENCY.

"The chemical agency of artificial light is analogous to that from the sun. In general the former is too feeble for producing any visible effect ; but light of considerable intensity, such as that from ignited lime, darkens chloride of silver, and seems capable of exerting the same chemical agencies as solar light, though in a degree proportionate to its inferior brilliancy."

PHOSPHORESCENT SUBSTANCES.

"Light is emitted by some substances, either at common temperatures, or at a degree of heat disproportioned to the effect, giving rise to an appearance which is called phosphorescence. This is exemplified by a composition termed Canton's phosphorus, made by mixing three parts of calcined oyster-shells with one of the flour of sulphur, and exposing the mixture for an hour to a strong heat in a covered crucible. The same property is possessed by chloride of calcium (Homburg's phosphorus,) anhydrous nitrate of lime (Baldwin's phosphorus,) some carbonates and sulphates of baryta, strontia, and lime, the diamond, some varieties of fluor-spar called chlorophane, apatite, boracic acid, borax, sulphate of potassa, sea-salt, and by many other substances. Scarcely any of these phosphori act unless they have been previously exposed to light ; for some, diffused day-light or even lamp-light will suffice ; while others require the direct solar light, or the light of an electric discharge. Exposure for a few

seconds to sunshine, enables Canton's phosphorus to emit light visible in a dark room for several hours afterwards."

"Warmth increases the intensity of light, or will renew it after it has ceased; but it diminishes the duration. When the phosphorescence has ceased it may be restored, and in general for any number of times, by renewed exposure to sunshine; and the same effect may be produced by passing electric discharges through the phosphorus. Some phosphori, as apatite and chlorophane, do not shine until they are gently heated; and yet, if exposed to a red heat, they lose the property so entirely, that exposure to solar light does not restore it."

"Mr. Pearsall has remarked that in these minerals the phosphorescence, destroyed by heat, is restored by electric discharges; that specimens of fluor-spar, not naturally phosphorescent, may be rendered so by electricity; and that this agent exalts the energy of natural phosphori in a very remarkable degree."

"The theory of these phenomena, like that of light itself, is very obscure. They have been attributed to direct absorption of light, and its subsequent evolution; but the fact, that the color of the light emitted is more dependent on the nature of the phosphorescent body, than on the color of the light to which it was exposed, seems inconsistent with this explanation. Chemical action is not connected with the phenomena;

for the phosphori shine in vacuo, and in gases which do not act on them, and some even under water."

PHOSPHORESCENCE BY HEAT.

"Another kind of phosphorescence is observable in some bodies when strongly heated. A piece of lime, for example, heated to a degree, which would only make other bodies red, emits a brilliant white light of such intensity, that the eye cannot support its impression."

DECAYING MATTER PHOSPHORIC.

"A third species of phosphorescence is observed in the bodies of some animals, either in the dead or living state. Some marine animals, and particularly fish, possess it in a remarkable degree. It may be witnessed in the body of the herring, which begins to phosphoresce a day or two, after death, and before any visible sign of putrefaction has set in. Sea-water is capable of dissolving the luminous matter ; and it is probably from this cause that the waters of the ocean sometimes appear luminous at night when agitated. This appearance is also ascribed to the presence of certain animalcules, which, like the glow-worm of this country, or the fire-fly of the West Indies, are naturally phosphorescent."



CHAPTER XXVI.

LIGHT AND HEAT IDENTICAL.

LIGHT and heat, then, we regard as the same thing. They coexist and are inseparable. All the perceptible difference between them consists in volume or degree, and in volume or degree *alone*, and not in nature. Light exists either *radiant* or in a state of *diffusion*, and consequently, *latent*. It is *radiant* when coming from the sun to the earth, but the moment it strikes the earth it becomes latent, but it is still *light* just as much, though not seen, as it was before, and could it be condensed into the same compass, and under the same circumstances as before, it would become just as radiant as before.

CONCLUSIVE ILLUSTRATION.

Heat is only light in a state of diffusion, as we before remarked. This is proven by the fact, that if you condense it sufficiently, you make it light. Take a piece of iron, for instance, and heat it to a certain point and it is still latent, or invisible, but condense a trifle more heat upon the iron, and it begins to be light; condense more still, and it grows lighter; and so continue, and you make it glow at length with a radiance almost as intense as that of the sun at noon.

day, but still it is only heat. Light, then, is only heat *condensed*, and the more it is condensed, the more intense is that radiance; and on the other hand, heat when latent, or invisible, is light in a state of diffusion. All the difference then between the two, is in volume or degree, and in volume or degree *alone*.

APPLICABLE TO ELECTRICITY.

The same remarks apply with equal force to electricity. When condensed in the electric spark, or in the galvanic current, or in the blazing thunderbolt, it is *radiant* electricity, but when not condensed, it is *latent* electricity, or electricity in a state of diffusion and invisibility. But whether radiant or latent, it is the same thing precisely, only accumulated in different volumes.

ERRONEOUS SUPPOSITION.

Some suppose, that when the electric spark or the thunderbolt explodes, the electricity is destroyed. That, however, is an erroneous supposition, as can be proven by experiment. It only passes into a state of diffusion, and consequent invisibility, but it is essentially the same thing as before, and could it be collected again, would exhibit the same appearance as before, and explode in a flash equally intense.

INTERESTING EXPERIMENTS.

Mr. Cross, a literary gentleman of England, passed

several conductors for some distance over the trees in his park, and connected them all with a single one, which passed down through his parlor. In this main conductor, which passed through his parlor, he had a joint so constructed that he could break the connection and leave a short interval between the two sections. Whenever he made the separation, whether in fair weather or in foul, there was a constant succession of brilliant electric sparks passing from one conductor to the other. Without this disconnection, the electricity would have passed over the conductor in just as great a volume, but would have been invisible or latent, and of consequence been the same precisely as if radiant.

EXPERIMENT WITH THE SPIRAL TUBE.

The fact that luminous and invisible electricity are the same, though condensed more in one instance than in the other, can be incontrovertibly proven, by an experiment with what is called the spiral tube or diamond necklace. Over the glass, at very small intervals, are glued little pieces of tin foil. There is probably a hundred of those pieces in a distance of two feet, and as many spaces between them. Now communicate a spark of electricity, either from the electric machine or a charged Leyden jar, and in its passage through the tube it will become alternately luminous and latent one hundred times in the distance of two feet, which certainly would not be the case if electricity is destroyed or changed at all by explosion. It is

latent when passing the tin foil, and luminous when passing the intervals, simply because it is more diffused upon the tin foil than in the spaces. Such an alternate arrangement of tin foil and spaces might be extended until they should number many millions, and an electric spark would become alternately luminous and latent as many millions of times in its passage over them. All the difference then between radiant and invisible electricity, is in volume or condensation ; and light and heat, as we have seen, exhibit precisely the same analogies.

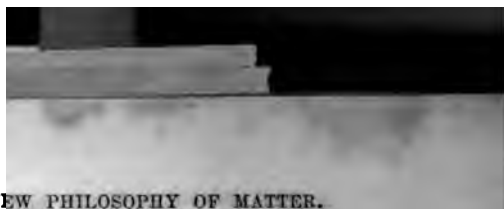
A MASS OF FACTS.

We will here briefly enumerate a mass of additional facts, which show the identity of caloric, light, and electricity.

Good conductors of heat are also good conductors of electricity, and poor conductors of the one are poor conductors of the other.

Heat affects bodies inversely according to the squares of the distance. This is the organic law of light, electricity, and magnetism. It speaks volumes in favor of the proposition that the sun is the fountain of all electricity, since the basis of this principle, which runs through all the imponderables, seems to be laid in the law of the divergence or radiation of light.

Heat radiates in all directions like light, and its angle of incidence and of reflection are the same.



warmer the weather, the more frequent they are, and the more vivid, rapid, and intense are the lurid flashes of the red bolt of heaven. They prevail in the northern zones in the summer, in the southern in the winter, and in the torrid regions throughout the year. This is the *modus operandi* of their doings.

ILLUSTRATION.

During the hot weather of the summer months, a vast amount of caloric is poured down from the sun, and diffuses itself throughout the waters of the fountains, rivers, lakes, and oceans of the globe, and produces evaporation; for it is a fact, which is generally acknowledged, and which no one will dispute, that caloric is the vaporizing agent the world over. This vapor, when generated, rises, we know, and forms the clouds. The caloric or heat, which originated it, is absolutely required to keep it in a state of vapor; for the moment it is abstracted by any process or cause whatever, that moment vapor ceases to be vapor, and is condensed into water again. This is proved by the condensation of steam in a low pressure engine, where, by the abstraction of its caloric by cold, it returns to water.

CLOUDS CHARGED PLUS AND MINUS.

Now, what takes place during a thunder storm, after a hot sultry day, in which vast quantities of vapor were generated, and with which vast quantities of ca-

loric rose to keep it in a state of vapor, what takes place, we ask, during a thunder storm at such a time? Why simply this. Clouds that are charged with caloric, some plus and others minus, or some positive and others negative, are drawn together, by the strong attraction of opposite polarities; two clouds, having an affinity for each other, rush together—the caloric which kept the vapor in a state of vapor, is thus given out from one to the other—explosion takes place—the cause which produced the vapor, and kept it so, having vanished, it is condensed, of course, into water, and being then heavier than the surrounding medium—heavier than the circumambient atmosphere, which before sustained it, it is immediately precipitated to the earth by gravitation, in the form of showers.

PROCESS OF NIMBIFICATION.

If a thunder storm be watched, during the process of nimbification, it will be seen that little dark clouds seem to congregate from every point of the compass, sometimes, and will conglomerate and thicken into deeper and deeper density and darkness, those which have the least caloric run the lowest, while those which have the greatest quantity run the highest; as they come parallel to each other, the lower strata will lift, while the upper will settle down, being attracted by each other, until they come within striking distance, when the plus of the upper strata is given out to the minus of

the lower, in the form of an explosion, and, during this concussion, a large share of the caloric, which was treasured up in the vaporous vesicles of both clouds, is abstracted in thunderbolts, and thus copious discharges of condensed vapor or water follow each flash.

WHY THE BOLT PASSES DOWNWARD.

This accounts for the reason why the bolt most generally passes downward from the cloud to the earth. The upper strata being plus, gives out its caloric to the lower, which is always relatively minus, and, therefore, the scathing fires of heaven oftener leap downward than in any other direction.

LIGHTNING IS LIBERATED CALORIC.

Lightning, then, or the electricity of the clouds, is nothing more nor less than caloric, abstracted from vapor by strong chemical affinities, and by explosion. It is radiant caloric, and caloric is Electricity. We believe that no philosopher or chemist can account for all the phenomena of the thunderstorm, and of the lightning, in any other way.

QUOTATION FROM METCALF.

To show that we stand not alone in the advocacy of such sentiments, we will quote from that rare and excellent work, by Dr. Metcalf, entitled "A New Theory of Terrestrial Magnetism."

"It was observed, long ago, by Dr. Franklin, that masses of vapor, in different states of electricity, attracted each other far beyond what he called the striking distance."

"It has probably been remarked by every person of observation, that light masses of vapor from the ocean, on approaching a mass of colder vapor from the northern points of the compass, approximate each other with accelerated velocity when the colder current of vapor attracts caloric from the warmer, and it is condensed into a hazy mist or cloud."

AERIAL CONDENSATIONS.

"This is the rationale of aerial condensation. When a cloud is once formed, having parted with a portion of its caloric, *it is minus* in relation to all uncondensed or transparent vapor, which is plus, so that it becomes a centre of attraction, drawing to it successive masses of vapor, and abstracting their caloric, by which a perpetual condensation or nimbification is kept up, until an equilibrium is restored."

CAUSE OF EVAPORATION.

"It would seem obvious to the most superficial observer, that caloric is the cause of evaporation, inasmuch as the greatest amount of evaporation takes place in regions which receive most of the sun's heat. We may form some idea of the vast amount of caloric contained in atmospheric vapor, when we reflect that

a pound of vapor will raise the temperature of a pound of water nearly 1000 degrees—that its bulk is increased about 1800 times in passing from a state of water to that of vapor, and that all the rivers of the earth are supplied by its precipitation.”

“What, then, becomes of all the caloric which must be given out during the condensation of this vapor? We know that thunder and lightning are most abundant in tropical regions, and during hot, sultry weather in the middle latitudes. Hence, we infer *that the caloric of vapor, when greatly accumulated, is given out rapidly, in the form of electricity, on approaching a colder mass of vapor, which is negatively charged with caloric.*”

• QUESTIONS ANSWERED.

But it may, in this connection, be asked, What causes rain, when lightning is not visible? The caloric is given out gradually, and in such a volume that it is latent. This is either done by the vicinity of cold and warm masses of vapor, or the attraction of mountainous ridges, or of the minus earth.

REASONS WHY IT RAINS NOT ON SAHARA.

If this be true, we can see at once the reason why, upon the great desert of Sahara, where there are no mountains, and where the earth is almost always plus, it rarely, if ever, rains. The earth being plus, and imparting caloric to the masses of vapor, as they float over it, rarefies them, and makes them float *higher*,

rather than aids in their condensation. It would be utterly impossible, therefore, for it to rain oftener upon that desert.

CAUSE OF CONTINUED DROUTH.

The same cause dissipates all appearances of rain in certain sections during the prevalence of a drouth, so that showers will pass round day after day each side of them, and seem to shun them. The earth has in those sections become plus, and rarefies the clouds as they pass by, floats them higher, and *prevents* condensation. As a general occurrence, such spots are encroached upon *gradually* by showers, until they are at length made minus, and then they are visited by the refreshing rain.

HOW RAIN COULD BE PRODUCED IN SAHARA.

Could a large tower be erected, some one or two thousand feet high, in the very centre of the great desert of Sahara, and could its top be kept filled with ice, it would be the cause of the *perpetual* nimbification of clouds, by its abstraction of their *caloric*. The consequence would be that it would be visited with frequent and vivifying showers.

SOLAR LIGHT THE FOUNTAIN.

The sun is the great fountain of light. Were it, however, extinguished, as in Byron's poetic dream on Darkness, there would be neither heat nor electricity,

and on the other hand, were there no heat nor electricity, there could be no light, for light is necessarily produced by the heat, which is indispensably requisite to render substances combustible, and without which they would not ignite, nor become combustible, nor luminous at all. They are inseparable from each other, and from electricity, and if you destroy the existence of the one, by the same process you destroy the existence of all.

THE SUN THE ELECTRIC RESERVOIR.

The fact is, the sun, which sends forth its streams of light and heat, is the great fountain of electricity—the great galvanic battery of the solar system. Could it be stripped at once of these splendors, which sweep incessantly over the vast domain of its dependent worlds, and be left a dark, cold, opaque body, what think you would be the consequence? Why, in less than twenty-four hours—yea, in less than twelve hours—this globe would become a solid mass of ice, from surface to centre, as well as every other body of the solar system. The very atmosphere would be congealed into an iceberg. The heart of nature would cease to beat. The pulse of nature would stand still. The powers of nature would all be palsied, chilled and frozen to death. In such a supposed contingency, the orbs, if they moved at all, would wander, cheerless, black, and without order, through the vast expanse of

desolation, dashing madly against each other in their blind and ungoverned career.

Or else, as is most probable in such a contingency, all motion would be stagnated, and every energy, every muscle, every nerve of the universe would be withered, stiffened, clothed with the rigidity of death. All sound would die away upon the palpable blackness of chaos. No elastic medium would convey the tones of harmony by its vibrations. All nature would be dumb.

SUPPOSED CONTINGENCY.

While thinking upon this subject, I have permitted imagination to have unfettered sway, and to sketch the gloomy picture of the reality of such a supposition. In doing so, no description of the scene that I could paint seemed so graphic as the language of Byron's poetic dream on *Darkness*, when

“ ———The world was void.

The populous and powerful was a lump,
Seasonless, herbless, treeless, manless, lifeless,
A lump of death—a chaos of hard clay.
The rivers, lakes and oceans all stood still,
And nothing stirred within their silent depths.
Ships, sailorless, lay rotting on the sea,
And their masts fell down piecemeal—
As they dropped, they slept upon the abyss without a surge,
The waves were dead. The tides were in their graves,
The moon, their mistress, had expired before,
The winds were withered in the stagnant air,
And the clouds perished. Darkness had no need
Of aid from them— SHE WAS THE UNIVERSE.”

This description, or a description like this, though almost horrid enough to make the blood run chill, would be no fiction. Should the light and caloric of the sun be abstracted from the universe, there would be no electricity. It would, with the rapidity of a flash, complete its circuit, and perish with its cause. It could be no longer excited by friction. No galvanic arrangement of metallic plates could produce it. And then motion would cease; all life would instantly become extinct, and darkness and death would reign triumphant and universal.

VALID CONCLUSIONS.

In view of the facts and arguments, which have already been submitted to the reader, we shall, now, consider it a conceded point, that we have *proven the identity between solar light, caloric and electricity*. To test, still farther the correctness of the principle advocated, we will proceed to account, if possible, for certain mysterious and hitherto inscrutable phenomena which can be satisfactorily accounted for, if our positions be, at all, tenable.

CHAPTER XXVIII.

POPULAR OPINIONS ABOUT MAGNETISM.

THERE have, for ages, been certain vague and indefinite ideas, floating in the public mind, respecting the cause of magnetic attraction. While some have thought, that there was a certain incomprehensible control over the needle of the compass exerted by the north pole star, others have approached somewhat nearer to scientific accuracy, by ascribing this controlling influence to terrestrial magnetism. But *how* terrestrial magnetism is produced, and by what laws it is governed, the latter class has been about as much in the dark, as the former. But, if the positions we have assumed be true—if solar light and heat be electricity, and, if the sun be its fountain, we have a key, which will unlock all this mystery, which has hitherto been so inscrutable. To this important and useful purpose we will then apply it.

THE TRUE THEORY.

How, upon the theory, that the sun is the fountain of electric influences, is terrestrial magnetism accounted for? The sun being the great galvanic reservoir, pours its streams of light and heat, *vertically*, upon

the space embracing 47 degrees of the earth's middle regions, or $23\frac{1}{2}$ degrees each side of the equator, constituting the torrid zone. Let the temperature of the other zones vary as it may, the heat of the torrid is always uniform, and always excessive, compared with either the temperate or the frigid zones. Thus the torrid regions, by being more directly under the influence of the sun's rays, become more deeply electrified, than either the temperate or the frigid.

EQUATOR PLUS AND POLES MINUS.

What is the consequence of the fact just stated? The equatorial regions are *positive* or *plus*, while the polar regions are comparatively *negative* or *minus*. There are two reasons for this. The 47 degrees, or the 3266 $\frac{1}{2}$ statute miles of the earth's surface, embraced between $23\frac{1}{2}$ degrees of north, and $23\frac{1}{2}$ degrees of south latitude, constitute the bulkiest part of the globe, and, even if the remaining part, including the north and south temperate, and north and south frigid zones, were as directly exposed to the sun's rays, as is the torrid, (which supposition is, however, an impossibility,) the equator would, in that case, still be plus and the poles minus, because the torrid regions are the bulkiest, and receive, therefore, the greatest amount of the electric fluid.

AN INFALLIBLE RULE.

But the principle reason why the one is plus and the other minus, is, because the one receives the rays of

the sun more vertically than the other. Now for the application of an infallible rule. The equatorial regions being plus, or positive, and the poles being minus or negative, there is a mutual attraction of the plus or superabundant fluid of the one, and the minus of the other, upon that immutable and universal chemical principle, that opposite polarities, or a positive and negative always attract, or that caloric always seeks to keep up an equilibrium or to restore it when disturbed.

Besides, from this immutable and universal law of caloric to keep up or restore an equilibrium, its particles, if they have opposite polarities and if the plus end in radiations, or emanations, always moves first, must present, at the magnetic equator, their minus polarities to each other, and of course, be continually repelled outward each way towards the poles.

TWO FORCES.

So, then, there are actually two forces operating upon the superabundant electricity or caloric of the equator. And what is the consequence of the combined action of those two forces. Why, there will be two strong currents of electricity, rushing, continually, with lightning speed, from the equator, each way, and these currents will, if this theory be true, run towards the point of greatest cold, north and south, instead of the geographic pole.

AN OBJECTION.

Some, perhaps, might contend that if the streams of caloric constitute the directive power which is exerted by some agent over the needle of the compass, they must move spirally, in order to exert that influence which is actually exerted. Such may confidently infer this, from the fact that certain experiments have been made which would seem to prove it. A sheet iron globe has been constructed, and so wound spirally from the north to the south pole, with insulated copper wire, that it would make the needle arrange itself north and south, whenever the galvanic current was sent through the wire from one pole to the other, by connecting the wires at the two poles with the poles of the galvanic battery.

THE OBJECTION ANSWERED.

But the inference that such must be the spiral course of the electric current around the earth, by no means follows from this experiment; for, it must be recollected that there are two different currents, or two currents running in opposite directions from the equator to the poles, with their polarities arranged, of course, in opposite directions, the same precisely as if, from the equator towards the poles of such a hollow sphere, two currents should be sent in opposite directions from two galvanic batteries. By such an experiment, it could be demonstrated, conclusively,

that the needle would arrange itself north and south, *without* having the galvanic fluid circulate around spirally.

But it would not discredit the correctness of our theory at all, if it were necessary that there should be spiral currents, for there is, doubtless, a *minor* current running spirally around the earth from west to east, owing to the fact that, by the diurnal revolution, that side of the earth which is in darkness is relatively minus, when compared with that part which is under the immediate influence of the sunlight.

EXPLANATION.

Now, then; for the explanation of magnetic attraction. It has been ascertained by experiment, that currents of electricity will influence the needle. The reason, then, why the north pole guides the needle when *north* of the equator, and the south pole when *south* of the equator, is perfectly obvious. These currents of electricity, rushing from the equator to the poles, constitute what is called terrestrial magnetism. They give direction to the needle of the compass. As the point of greatest cold varies, so they vary, and as they vary so the needle varies.

GEOGRAPHIC POLE NOT ATTRACTIVE.

Were the geographic pole of the earth the point of attraction, as has been supposed by some, the needle would *never* vary *at all*, but, as it is, it varies both

diurnally and annually, because there are causes always operating at the north pole to change the point of greatest cold, particularly in the summer season, when the floating icebergs or ice-islands of the Arctic are continually changing their position.

MYSTERIES SOLVED.

There are other mysterious phenomena which can be rationally and philosophically accounted for, *only* upon the supposition that there are such currents of electricity as we have been describing. They are the Aurora Borealis and Aurora Australis, or the northern and southern lights, for there are southern lights as well as northern. If caloric be electricity, as we have supposed, and there are currents passing from the torrid to the point of greatest cold in the frigid zone, the question arises, "what becomes of this electric fluid, when it arrives at that point of greatest cold?" Why, it streams up into the rarer regions of the atmosphere, and in its return to the equator it spreads out into the lambent, waving light, exhibited by the aurora, the appearance being the same precisely as electricity exhibits when passing through an exhausted tube, the same cause—the rarity of the atmosphere—operating in both cases to produce a luminous, waving cloud, which proves that they must be identical.

As we progress in the investigation of this subject, we find evidence accumulating upon evidence, all

linked together, and all sustaining the truth of our main proposition.

OBSERVATIONS OF PARRY AND ROSS.

Captains Parry and Ross ascertained, in their expedition to discover a north-west passage, that the focal point, from which streams upward the aurora borealis, was exactly the point of magnetic attraction; for, when sailing over that point, the dipping needle stood exactly perpendicular, while the horizontal needle would not traverse at all, but would remain in any position in which it was placed. When west of that point, their dipping needle would incline to the east; when east of it, it would incline to the west. They occasionally found that the focal point, or the point from which the aurora borealis streams upward, was south of them, and in that case the north pole of the needle turned round and pointed southward, so that, let them move wherever they might, its guiding influence on the compass was still the same.

They also ascertained another important fact—that this point of attraction was comparatively that of the greatest cold.

All these facts combining their evidence, and sustaining that of each other, can there be any rational doubt, but that the caloric of the equator is electricity?

FACTS CHAINED TOGETHER.

See how admirably these facts are linked together, and how each sustains the ultimate conclusion. Caloric streams down from the sun—deeply electrifies the equatorial regions—by a law of nature rushes towards the greatest cold of the poles—guides the needle invariably towards that greatest cold—streams upward, as it passes out from the magnetic pole—rises into the rarer or thinner regions of the atmosphere, and, like electricity in its passage through an exhausted tube, spreads out into a luminous cloud, and forms the Aurora Borealis at the north, and the Aurora Australis at the south.

LOGICAL INFERENCE.

Now, can there be any stronger proof, or any greater accumulation of proof, that caloric is, in fact, electricity, short of actual mathematical demonstration? One, who could not be convinced by such an array of facts, each supporting the other, could hardly be convinced, we should be inclined to suppose, by the evidence of his senses. He would be like that ancient sect of sceptical philosophers, who doubted everything—even their own identity.

CHAPTER XXIX.

GRAVITATION.

IN continuation of our explanations of various mysterious phenomena of nature, which have heretofore been left unexplained, or enveloped in a metaphysical fog, we would remark, that there are yet other important and essential links, in the chain of evidence which we have been linking together, all of which have a tendency to make the logical accuracy of our deductions more clear, and our conclusions more and more undeniable and convincing.

Gravitation, another imponderable principle of nature, is one of those links—a link too, which, so far from diminishing or impairing, in the slightest degree, the strength of the previous chain of deduction, adds to it increasing power of tenacity, and resistance to efforts of prejudice or scepticism to break it—a link, which is intimately connected, as we shall attempt to show, with the mysterious power of electro-magnetism.

HERETOFORE UNACCOUNTABLE.

No topic, in the whole range of the sciences, has heretofore seemed to students more unaccountable—more involved in a dark and misty shroud of uncer-

tainty, than gravitation. Upon what known philosophical, astronomical, or chemical law, bodies, within a certain distance, are attracted *towards* the earth, has, for a long time been regarded by the learned and treated as an inexplicable enigma.

It is no solution of the riddle—no satisfactory explanation to affirm, that it is *attraction*. If the attempt be made by any one, so to define it, the question instantly suggests itself to the unsatisfied mind of the diligent inquirer after truth—what causes this attraction—why do all bodies, when unsupported in mid air, fall *to* the earth, instead of flying off in a tangent—*away* from it, into space? We answer, that there must be some *definite* reason existing in the nature of things for this phenomenon. What, then, is that reason?

UNSATISFACTORY EXPLANATIONS.

It will not avail any thing, as we have seen, to say that it is attraction, or that it is the attraction of gravitation. This method of solving the enigma would only be reasoning in a circle, as logicians would call it—would be only giving a simpleton's solution, by saying that a thing is so, *because* it is so. It conveys no definite idea to the mind—is referable to no general scientific law. So far as purposes of lucid and perspicuous illustration are concerned, it might just as well be said, that attraction of *attraction* causes that known disposition of bodies to seek the

earth, as to be said, that the attraction of *gravitation* causes it ; for the words defining the *cause* are, in both cases, equally vague, having no definite idea attached to either of them.

If we are told that all bodies of any bulk or density, have an inherent tendency to approach other bodies of matter larger and heavier than themselves, upon the principle of attraction, and that this is the attraction of gravitation, is it any explanation at all ? Certainly not. Instead of throwing any light upon the subject, it is only the substitution of one vague term for another term equally vague. The question still rushes upon the unsatisfied mind, with undiminished force, "What *causes* this gravitating tendency ? Why do bodies tend downward towards the earth instead of upwards from it ?"

Shall it be said that it is an insolvable mystery, which is beyond the ken of human investigation, and so let it pass ? Will men permit themselves to be thus baffled in their researches into the nature and causes of things by difficulties which, perhaps, a stern and unbending perseverance might overcome ? This would be neither wise nor manly. There is not, we are persuaded, the cause of a single solitary effect of any kind in the universe, except the great uncreated Cause of *all* effects—or, in other words, a single secondary cause of any effect whatever, which may not, in time, by patient and persevering investigation—

by comparing laws, and agencies, and influences, be satisfactorily ascertained.

FUNDAMENTAL LAWS.

What, for instance, is a fundamental law of electrical attraction? Why, an excited body attracts an unexcited body, that approaches it in exact proportion to the squares of the distance. Iron, when temporarily magnetized by the galvanic or electric fluid, or steel, when permanently magnetized, attracts contiguous metals precisely in the *same proportions*; and, although magnetism and electricity were once thought to have no sort of alliance with each other, they are now proven, beyond controversy, to be but one. And what may we infer from this coincidence between the two, and the identity of their laws and agencies? Why, that any other imponderable, which shall exhibit the operation of the *same governing laws*, without a *shade* of difference, may also, yea, and will be found to be produced by the very same *cause*, upon the immutable principle of nature, that like causes produce like effects.

THE KEY TO THE MYSTERY.

Here, then, we have a key to unlock the mystery of gravitation—a rule to solve every enigma and every difficulty satisfactorily. The attraction which the earth exerts over loose bodies above its surface is

governed by the very same laws precisely as magnetism and electrical attraction—it draws them with a force which varies in inverse proportions according to the squares of the distance.

GRAVITATION IS MAGNETISM.

Gravitation, then, is nothing more nor less than terrestrial magnetism, produced, as all magnetism is produced, by electricity, and that electricity, streaming down from the source of all electricity—the sun. Before this theory, every difficulty which surrounds the subject of gravitation vanishes at once. The phenomena of bodies gravitating towards the earth can be thus accounted for by the operation of known, and acknowledged, and tested scientific laws. The earth is, in fact, a magnet, exhibiting all the properties of a magnet, attracting the needle to the pole like a magnet, drawing bodies to itself with a force precisely conformable to the attractive force or influence of a magnet, is made a magnet by electricity, and that electricity is the light and caloric that stream from the sun. The attraction of gravitation, then, is the attraction of terrestrial magnetism.

AN ERRONEOUS OPINION.

It has been the current opinion among the mass of the community, and even among scholars, that everything is attracted towards the centre of the earth, as though that possessed some mysterious, unaccountable

power of attraction over substances, somewhat akin to the unphilosophical opinion that the north pole star guides the needle of the compass, and that this attraction is increased all the way to that centre. But such is by no means the case. The attraction of gravitation, instead of being the greatest at the *centre*, is the greatest at the *surface* of the earth.

ILLUSTRATION BY A SUPPOSITION.

Were it possible, for instance, to perforate *through* the earth exactly at the magnetic centre, instead of the geographic, a substance which might weigh hundreds of tons at the surface would weigh just nothing at all at that centre. It would be suspended there, were the space large enough, without any apparent support, like a light needle when suspended within a helix, or coil of insulated copper wire, while passing a current of galvanism around it. And why would this be the case? Because the electrical or magnetic attraction would be equal on all sides of the centre of the earth, and, therefore, a substance which would weigh several tons at the surface would there be perfectly balanced, without support, and would, in that position, weigh just nothing at all, since all weight depends upon attraction, and that weight is exactly proportional to the attraction. As the power of the attraction is equal on all sides of the centre of the earth, and as attraction *one way* without a corresponding attraction the *other*, causes all weight,

therefore, a substance at this centre must weigh nothing, because the attraction being in all directions equal, must be neutralized.

ATTRACTION GREATEST AT THE SURFACE.

The attraction of gravitation, or in other words, the attraction of terrestrial *magnetism*, which is the same thing precisely, is the greatest at the *surface* of the earth. It may be asked, then, Why do all falling bodies, fall toward the centre? Simply because the radiations of magnetism obey the same law, precisely as the radiations of light. The lines of these radii if continued on within the surface, or through the earth from one side to the other, would intersect the centre, and the attractions of the surface are, therefore, directly *towards* the centre.

GRAVITATION OBEYS THE LAW OF RADIATION.

From the fact, that the radiations of magnetism obey the law of the radiations of solar light, and all other light, that is, from the fact that the divergence of the radiations of magnetism is, in the exact proportion of the squares of the distance, the same as the divergence of light, Gravitation, therefore attracts all bodies around it in proportion to the squares of the distance of those bodies. So that the organic laws of magnetism, light, and gravitation are the same, and like *laws* produce like effects as well as like *causes*.

A PROPOSITION DEMONSTRABLE.

Before dismissing the interesting subject of gravitation, we would express our belief that it is a proposition capable of demonstration, that an increase of the material of the earth, would increase its attraction in precisely the ratio of the increase of the attraction of the magnet, by the increase of *its* material. Were the material of the earth *doubled*, for instance, its attraction would be *quadrupled*, precisely in accordance with the law of the divergence of light, or the radiations of electricity. Consequently the weight of all bodies upon its surface, of the same bulk and density, would, in such a supposed contingency, be quadrupled in accordance with an immutable law.

LOGICAL CONCLUSIONS.

Now, from all that has been said, does it not appear perfectly evident, that gravitation has a cause as definite and as easily explained as magnetism, which cause is precisely the same.

PROF. HENRY'S GREAT MAGNET.

The great magnet of Professor Henry, for instance, to which we have already alluded, would, when fully charged with the galvanic current, *neutralize* all the power of the *earth's* gravitation, and make a body gravitate *upwards* from the earth with a power equal to *two or three tons*. And why? Simply because a

vast volume of electricity was accumulated there in a small compass, by means of the insulated copper wires, around which the galvanic fluid circulated. Electricity or light, then, we can legitimately conclude, is the *cause* of gravitation.

CHAPTER XXX.

ATTRACTION OF COHESION.

THE attraction of cohesion has the same cause as the attraction of gravitation. They are both, doubtless, produced by that electric cause, the light and caloric of the sun. The one is the attraction between *large masses*, and the other between the component *particles* of those masses, the one attracts at great distances, and the other at insensible distances—their attractions are, therefore, the same in essence, though not in volume or degree.

What holds the armature of Henry's large magnet, when charged, but the simple power of cohesive attraction between the particles of the iron, which composes the material of the magnet and armature, which cohesive power is caused by electricity? We believe it is nothing else.

The same power, precisely, holds the particles of all bodies together, and that power of cohesive attraction varies often as the amount of *latent caloric* varies. Abstract the latent caloric of iron, for instance, by intense cold, or by any other cause, and you, in a proportionable degree, destroy its cohesive attraction and

make it brittle. This is proven by the ease with which iron is fractured in the intense cold of the winter.

AN IMPORTANT FACT.

By hammering iron when cold, or by rolling it in a rolling mill, it will also become brittle. And why? Because the caloric which constitutes cohesive attraction is pressed out upon the surface, by closing the pores. This is proven by the fact, that caloric accumulates upon the surface in proportion as the pores of the iron are contracted by the rolling mill or the hammer which drive out the latent caloric.

CAPILLARY ATTRACTION.

The various phenomena of capillary attraction can be referred to the same cause, as cohesion—to the caloric, that electrifies all substances under its influence. The tallow, that composes the candle, for instance, is drawn up into the wick, during combustion, by capillary attraction, and that attraction is caused by the caloric set free during ignition.

CAVILS.

We are well aware, that many objections to the validity of our positions can be started by fruitful imaginations, which may appear plausible and seem to conflict with the conclusions which we have drawn, but which must be deceptive, since the laws of nature do not clash, and, if some of the reasons, and the

modes of her operations are beyond the ken of the acutest and most penetrating scrutiny, it amounts to no conclusive proof that we are incorrect. The question is simply this. Have our deductions appeared rational, and in accordance with known and tested laws, and have they been amply sustained by an accumulation of appropriate facts? If so, we are under no obligation to explain mysteries in the *essential attributes* of an agent, while we are attempting to trace merely the *effects* of that agent, for most of those objections, which are or may be started, will be found, upon close scrutiny, to relate to *essence* rather than to the *modus operandi*, of that essence.

PUZZLING QUERIES.

Such questions as these, for instance, may be asked by the cavilling objector. If caloric be the *cause* of cohesive attraction, why will its accumulation entirely *destroy* cohesive attraction, as in the instance of all melted metals? Or, if caloric be electricity, and, if electricity be magnetism, why does not its accumulation around the large galvanic magnet, make that large magnet hot? Or, why will this agent, under one set of circumstances, produce an effect, and under another, *destroy* that same effect, it produces, if "like causes produce like effects?" These, and a thousand other questions, might be proposed by the objector, which are more easily asked than answered.

COUNTER QUERIES EQUALLY PUZZLING.

But, to show that they relate to *essence*, we will ask some questions equally puzzling, about electricity, where there can be no mistake about the identity of the agent. Why will the very same current of galvanism produce *both* an *acid* and an *alkaline* taste? Why will electricity, under one set of circumstances, make a magnet, and why, under other circumstances, will it *destroy* that same magnet. It will be readily perceived, that it is much easier to "*ask* questions than to *answer* them," and that such questions refer rather to an explanation of *essence* than of *effect*.

THE ESSENCE OF ELECTRICITY INEXPLICABLE.

That *essence* of electricity we never attempted, nor have we ever proposed, to explain. It is a wonderful agent, and as mysterious as it is wonderful. Its effects are varied by countless myriads of modifications, and these effects we investigate, rather than the inscrutable reasons, why those modifications should be so multitudinous, and why they should, in some cases appear to clash.

To show that we stand not alone in the advocacy of the opinion, that cohesive and capillary attraction are produced by caloric or electricity, we will quote from Metcalf's "New Theory of Terrestrial Magnetism." Speaking of caloric he says: "It seems to be a general law of this subtle element, that it repels its own par-

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ticles, and is attracted, though unequally, by all other matter, with an increased ratio, as the squares of the distance diminish."*

QUOTATION FROM METCALF.

"From this it follows, that when caloric is withdrawn from a body, that body has a stronger affinity for caloric than one which is filled with it; and two bodies charged with caloric, one plus and the other minus, will attract each other with a force proportioned to the different quantities of caloric which they contain, and to the rapidity of its conduction from one to the other."

A DISAGREEABLE EXPERIMENT.

"An experiment, which I inadvertently made when a child, strikingly illustrates this principle. On the morning of 'cold Friday,' as it was called, through the Western country, I applied my tongue to a plate of cold iron, while the mercury was about 15 degrees below zero, when it adhered with such force, that the skin was removed on separating it. Captain Scoresby relates, that frequently such was the intensity of cold in the Arctic seas, that the hands of the sailors adhered fast to whatever metals they touched."

* We do not believe in the above proposition, so far as reciprocal attraction is concerned. This would, as we have elsewhere shown, destroy the "vis inertiae" of ponderable matter.

In all such cases the temperature of the living body is from 115 to 140 degrees higher than that of the metals: in other words, the living body is charged plus, while they are minus; and the attraction continues until the equilibrium is restored, when it ceases.

The same attraction takes place when the hand is applied to metals heated greatly above the temperature of the living body; and for the same reason, one of the two bodies being charged plus and the other minus.

METALS BECOME BRITTLE.

“When the temperature of metals is greatly reduced, they become brittle, so that a slight blow will fracture them; the same effect is produced on iron by hammering which presses out and expels from it that portion of caloric which is necessary to its cohesion and malleability. Hence it follows, that a certain amount of caloric between the particles of matter is requisite to maintain their cohesion; but when the amount of caloric is increased beyond a certain extent, it separates the particles, and thus diminishes, or overcomes the power of cohesion.”

CAPILLARY ATTRACTION.

“A great variety of facts may be adduced to show that *capillary attraction* is owing to the operation of the same law. For example, if a piece of sugar be put into a glass of water, a portion of the caloric of fluidity leaves the water, enters among the particles

of sugar, and diffuses itself equally throughout the whole. During this absorption of caloric by the sugar, the temperature of the resulting mixture is somewhat reduced, proving that, in relation to the water, the sugar is minus or negative, and the water is plus or positive."

EXPERIMENT WITH SUGAR.

"If the piece of sugar be cut into a cylindrical form, of one or two inches in diameter and five or six inches long, and one end of it only be inserted into a glass of water, the caloric of the positive fluid being *strongly* attracted by the negative sugar, pervades it rapidly throughout, until the equilibrium is restored, when the entire mass is dissolved."

LEHOT'S EXPERIMENT.

"M. Lehot, found by experiment, that under the same pressure, water rises higher in vertical capillary tubes, as its temperature is elevated." (Bibl. Univers. Mars. 1820, p. 255.)

PHENOMENA OF A BURNING CANDLE.

"The phenomena of a burning candle illustrate the agency of caloric in producing capillary attraction in a very striking manner. The wick is ignited, the tallow rendered fluid, and attracted by caloric so as to furnish a continual supply of combustible matter to the wick, which is decomposed and expanded into

flame or light. The force and rapidity of capillary attraction, all other things being equal, are in proportion to the amount of heat given out in the wick."

"Capillary and cohesive attractions are only modified effects of the same cause. It is the attraction of caloric for the particles of water that holds them together ; that gives its drops their globular form ; as it is the attraction of caloric for porous solids, and capillary tubes, that raises the water above its ordinary level."

CHAPTER XXXI.

PLANETARY MOTION.

IF light and caloric be electricity, and the sun be the sole fountain from which it issues, as we have attempted, in previous chapters, to demonstrate, then its influence over the planets, that revolve around it, must also be an electric influence. If their motions are produced by the influence of the sun, then those *motions* must be governed by the laws which govern the electric agent.

SUBJECT VERY IMPORTANT.

We approach the discussion of this subject with the feeling that it is the most important, as well as the most interesting of any contained in the whole work. If we shall demonstrate that the revolutions of all the planets, both diurnal and annual, can be philosophically accounted for, in accordance with those organic laws of electricity, which have been, and may be ascertained definitely, in the laboratory, in their action upon pith-balls or electrometers, then will our opinions upon this subject be triumphantly sustained beyond the influence of cavil, and their correctness incontrovertibly proven.

But if we shall not be able to demonstrate such an identity, then will it appear conclusive that we have been indulging in philosophical dreams, or baseless chimeras of the brain.

ELECTRICAL EFFECT UPON PITH-BALLS.

What, then, are the forces which electricity exerts over pith-balls? They are two, which, as we have heretofore abundantly shown, have their basis in the inherent organic laws of this agent, and depend always for their development upon a plus and minus.

CENTRIPETAL AND CENTRIFUGAL FORCE.

And what are the two forces which have ever been supposed to govern the motions of the planets? Why, they are what philosophers have denominated centrifugal and centripetal forces. The meaning of the one is, a tendency to fly from a centre, and that of the other a disposition to seek the centre.

EQUIVALENT TO ATTRACTION AND REPULSION.

Now, these terms are, as any one must see, exactly equivalent to attraction and repulsion. Centrifugal is repulsion, and centripetal is attraction. So, then, we find that we have to bring to our aid no new forces, if we adopt the hypothesis that the influence of the sunlight upon the solar system is electric, since its two organic forces correspond exactly to the centrifugal and centripetal of all standard works.

DIURNAL MOTION EXPLAINED.

How, then, is the diurnal motion of the earth, for instance, produced upon this hypothesis, taking the movements of this globe for example, since they are more familiar than those of any other planet? Why, simply in this manner. The sun illuminates one-half of the surface of the globe, while the other half is in darkness. That hemisphere which is in darkness is relatively minus, when compared with that which is illuminated, and so, vice versa, that hemisphere which is under the direct influence of the radiance of the sun, is relatively plus, while the other is minus. The plus of the one side will increase from morning until sundown, and the minus of the other from sundown until morning. This is in accordance with that tested fact, that, if any substance be exposed to an electrifying cause it becomes plus, and the longer it is exposed to that cause the more highly plus it becomes; and so, on the contrary, if any substance be removed from the electrifying influence it becomes minus, and the longer it is removed the more deeply minus it becomes. Now, what is the legitimate result of such a condition of the earth? That part of the earth which has been longest in the sun's rays has come, as we have said, to a highly plus or positive state—that is, it has come to that state in which, throughout the torrid regions and part of the temperate, there must be an outward emanation, which constitutes a plus or positive, since any substance ex-

posed for any length of time to the electrifying cause must become positive.

INFERENCES.

By an immutable law of electricity, two positives repel. Therefore, that part of the earth which has been longest in the sun's rays, having come to a positive condition, is repelled by the positive sun. But that part which has been the longest removed from the direct influence of the electrifying cause, and has therefore come to a deeply negative condition, would, of course, be attracted by the positive sun, since a positive and negative always attract. If this were the true principle of the revolution of the earth upon its axis, the plus part of the earth must be always rolling *away* from the sun, while the minus part must be always moving *towards* it, from the fact that two positives always repel, and a positive and negative always attract. And this *is* the case, not with the earth only, but with all the planets which compose the solar system. That part of all of them which has been longest *in* the sun's rays is always rolling away from him, while that part which has been the longest *out of* his rays is always rolling towards him.

ROTARY MOTION PRODUCED BY TWO FORCES.

In producing the rotary motion of the earth, then, upon its axis, it is evident that the sun exerts two forces upon it, the one of attraction and the other of

repulsion, which would cause its diurnal revolution, since, if you strike a ball on each side with equal force, and in opposite directions, you give it the rolling motion.

The earth, then, revolves on its axis daily, by the influence of the two forces of attraction and repulsion, exerted over it by the sun, and those are precisely analogous in every respect to those of electricity.

HOW DOES THE SUN GOVERN DIURNAL MOTION?

If this be not the precise influence which the sun exerts over the earth in the production of its diurnal motion, what is that influence? It is universally acknowledged that the sun *governs* all the motions of the earth; but, while such an acknowledgement has been made, there seems to have been no clear or well-defined idea in the minds of those who have made such an acknowledgment as to what constitutes that ruling power. They have almost universally taken it for a conceded proposition, that such a ruling power of nature controls the movements of this globe of ours, but *how* it exerts such a control they seem scarcely to have taken the trouble to inquire.

GOVERNED ACORDING TO DEFINITE LAW.

But if the sun governs the motions of the earth, it governs those motions in accordance with uniform, well-defined and immutable laws. Now if any one affirm that the sun controls the movements of the

earth, he is bound to explain the principles of that government. If he cannot, how does he know that there is any such government *at all*? He has no right to assert that one thing is governed by another without he can give some definite reason, or reasons, *why* he draws such a conclusion. Nor has he any right to object to conclusions which others have drawn from well-defined premises, and deductions founded in reason, and sustained by well attested facts.

OUR THEORY BASED ON TESTED LAW.

We, for instance, have assumed the proposition to be true, and have endeavored to prove it, that electricity is the cause of all attraction and repulsion, upon both a large and small scale, and, consequently, of all motion among spheres as well as atoms, and that the sun is the *fountain* whence it originates. As part of a connected chain of antecedents, and consequences, or of causes and effects, we have drawn the legitimate conclusion, from the practical results of this theory, that the sun governs the earth and the other planets of the solar system by an electric influence. That influence has been *tested* in the laboratory upon pith balls, and is, therefore, acknowledged by all who pretend to any very extensive attainments in science.

LET THE OBJECTOR GIVE OTHER LAWS.

Now we have shown that the diurnal motion of the earth can be produced by the streams of electrifying

sun-light *precisely* in accordance with those known, and tested, and universally acknowledged electric influences, which are of every-day occurrence, and are familiar to every school boy. And if objections be urged against such conclusions, those who urge them ought certainly to be prepared to explain the laws by which the sun governs the earth, more satisfactorily and plausibly, or else forever hold their peace, and acknowledge their incompetency to do it: for the old stereotyped method of explanation, by referring the whole to the influence of the centrifugal and centripetal forces, without explaining *how* those two forces are produced, will not answer—will satisfy no inquiring mind.

OBJECTORS ANSWERED.

Feeling the force of the deductions which we have drawn, and seeing the impossibility of denying our conclusions, if our premises be correct, some may be roused by the impulses of their alarmed prepossessions to attack some of those premises. They may deny that the earth becomes minus during the night, and, therefore, infer that there are no two forces of the kind we have mentioned. But such cannot have investigated the subject at all. The earth is a rapid radiator of caloric, and, therefore, when the cause of it is removed, it rapidly dissipates. The consequence is that, although the emanations of caloric are outward from the earth during the day, especially in the torrid

zone, they are inward from the atmosphere to the earth at night, as is proven by the deposits of dew, for these deposits result from the abstractions, by the minus earth, of the caloric of the vapor which was generated in the day time, and rose from the earth by the force of emanating, or plus, caloric. The passage of caloric is, therefore, into the earth at night, from the surrounding atmosphere, and, of course, presents its minus polarities, as all inward currents do. This objection falls, therefore, to the ground, for the want of the shadow of a support, and so would every other objection, we believe, because our explanation of the phenomena of the revolution of the earth is in accordance with the immutable laws of nature.

CHAPTER XXXII.

MOTION OF OTHER PLANETS.

As we have already remarked, all the other primary planets obey the same laws precisely, or are governed by the same influences, in their rotary motions upon their axis, as the earth.

OBJECTION.

An objection may, however, be urged against this conclusion, from the fact, that there is no uniformity in the diurnal revolution of those whose motions have been ascertained with certainty, since Venus turns on her axis in twenty-three hours and twenty minutes, the Earth in twenty-three hours and fifty-six minutes, Mars in twenty-four hours and thirty-nine minutes, Jupiter in nine hours and fifty-five minutes, and Saturn in ten hours and sixteen minutes.

THE OBJECTION ANSWERED.

Now, why is there so much dissimilarity in the revolution of these planets, if there be a common cause for it, and if the laws which govern that common cause are invariable? It must be owing to the different materials which compose them, to their different

powers of radiating caloric, to their different distances from the sun, and also doubtless to their bulk. Venus is some twenty-eight millions of miles nearer to the sun than this earth, and its day is thirty-six minutes longer than ours. Upon the supposition that the power or capability of each planet to radiate caloric decreases in exact proportion as the squares of the distance from the sun increase, about which we shall soon remark more at large, then the revolutions of each primary planet would be regulated in exact proportion to bulk and distance.

VENUS, EARTH, AND MARS.

The difference between the relative distances from the sun of the Earth and Mars, is forty-eight millions of miles, and the difference between the time of their revolutions is forty-three minutes. Now, if we take those three planets, Venus, the Earth, and Mars, for data whereupon to make our calculations, we can determine, with mathematical certainty, whether any other causes than mere bulk and distance influence the rapidity of their revolutions.

DIFFERENCE OF BULK AND DISTANCE.

The difference between the bulk of Venus and the Earth, in diameter, is two hundred and forty miles ; between their distances from the sun, is twenty-eight millions of miles ; and between the time of their revolution, or the length of their day, is thirty-nine

minutes ; while the difference between the bulk of the Earth and Mars, the next planet, is three thousand seven hundred and thirty-nine miles, between their distances is forty-eight millions of miles, and their time forty-three minutes. Into this account is to be taken the bulk and influences of the Moon, which the Earth carries along with it.

DIURNAL MOTION GOVERNED BY DISTANCE AND BULK.

Without having space to enter into all the minutia of a mathematical calculation in the present connection, it is our impression that, with these data before us, it can be perfectly demonstrated, that the rapidity of diurnal revolution depends alone upon bulk and distance from the sun combined.

PHENOMENA ACCOUNTED FOR.

This accounts satisfactorily for the reason why Jupiter and Saturn revolve upon their axis in less than half the time of the revolution of our earth, although the one be three hundred and ninety-five millions of miles further from the sun than the earth, and the other eight hundred and five millions further ; for Jupiter has a diameter about twelve times as great as our earth, making its bulk more than a thousand times greater than this planet, besides carrying with it four large moons ; and Saturn, exclusive of the weight of his enormous rings and *seven* moons, is nearly six hundred times larger than the earth. They

may, therefore, in exact accordance with our data, both perform their diurnal revolutions in less than half the time of our earth.

POWER BY WHICH PLANETS ARE HELD.

Having come, by our deductions, to the conclusion that the rapidity of revolution depends upon the bulk of the planets, and their relative distances from the sun, we would here remark, that if the power or capability of the planets to radiate caloric, decreases according to the squares of their distance from the great centre of the system, then there is a *definite* cause why they all occupy just the position they do. Were this the case, they could come no nearer to the sun than they now do, nor could they remove farther away from it, but must remain just in the position they do at present, and have done since creation, so long as their material remains the same, or they have the same power of retaining or radiating caloric.

REASON.

For, if they should come any nearer, it is evident that they must become plus, and so be driven back by the repulsion of two positives. And, if they should recede farther from the centre, they would become minus, and so be drawn to the position whence they started, by the attraction of a positive and a negative. It is perfectly evident, then, that the planets are completely balanced in their orbits. They can neither

fly away from them, nor can they be drawn into the sun, for the agent that rules them, and governs all their motions, holds them just where they are, with bonds which cannot be broken until the final "wreck of matter and the crash of worlds." Owing to this cause alone, the earth approaches the sun in one part of its orbit, and is driven back in the other, the two forces keeping it balanced exactly in strict accordance with that law of caloric, which has a tendency to keep up an equilibrium throughout nature.

PHENOMENA OF THE MOON.

The moon is a dependent of our earth. It has no axis of revolution, nor independent motion, but it revolves around the axis of the earth just as though it was a component part of it. This being the case, it always keeps nearly the same face towards the earth, so that no inhabitant of this mundane sphere has ever seen the opposite side of the moon, nor has any being, who has *always* resided on the opposite side of the moon ever seen our earth.

TIME OF ITS REVOLUTION.

One complete revolution of the moon around the axis of the earth is accomplished in 29 days, 12 hours, 44 minutes and 3 seconds. Its day is therefore about as long as $14\frac{3}{4}$ of our days, and its night $14\frac{1}{4}$ times as long as our night.

DIRECTION OF ITS REVOLUTION.

The direction of the moon's revolution around the earth is the same as that of the earth upon her own axis, from east to west. And why? Because the power which the earth exerts over the moon in controlling its diurnal revolution must of necessity be exerted in the direction of her own revolution, thus, by her moving attraction, pulling the moon also around her.

THAT POWER.

And what is the power that overcomes this necessary tangential force of the moon, owing to her rapid motion around the axis of revolution, which propels her in the circuit of her diurnal course, and carries her along with the earth in their yearly journey around the sun? It is magnetism or gravitation, just which you please to call it, for they are identical, and that magnetism is caused by sunlight.

THE FORCES RECIPROCAL.

These forces of magnetic attraction between the earth and moon are necessarily *mutual*, and just sufficient to overcome the tangential force of this satellite, and keep it forever nicely balanced in its orbit.

All the satellites of all the primaries are governed by the same forces and laws, and exhibit nearly the same phenomena as those of our moon, which we have here described.

DIFFICULT PROBLEM.

Having accounted, rationally, for the revolutions of the planets upon their axes, upon the principles of electrical attraction and repulsion, how shall we account now for their annual revolutions around the sun? This, we confess, is a subject much more abstruse, and the problem is much more difficult to solve. But yet, we believe that it is capable of being satisfactorily solved, in accordance with the very same electrical principles, which we have already fully explained and tested.

But before we proceed to do this, it is necessary for us to state a few facts, which will aid materially in the solution of this problem.

DIRECTION OF MOTION.

Not only do all the planets revolve one way upon their axis, but they all move in one direction around the sun. Their motions, also, decrease in regular proportions and gradations as they recede from the sun. Mercury, for instance, moves in her orbit one hundred and eleven thousand and ninety miles per hour—Venus eighty-one thousand—the Earth sixty-eight thousand—Mars fifty-six thousand—Jupiter twenty thousand—Saturn, according to Ferguson, eighteen thousand, and Herschel fifteen thousand.

THE LAWS OF MOTION.

It will be seen that their movements are regulated by distance from the sun, combined with bulk, and we believe it to be a proposition capable of absolute demonstration, that the decrease of the motion of all the planets in their several orbits, would be in exact proportion to the squares of their distances from the sun, if they were all the same bulk and density exactly taking the present ratio of their movements, as correct data from which to draw conclusions.

EXPLANATION OF ANNUAL REVOLUTION.

Now, then, for the explanation of the annual revolutions of the planets. The sun seems to turn on his axis once in twenty-five days. That may be nothing but a seeming revolution, owing to the movement of its emanations in vast orbits as we have before remarked, and which would convey that impression to an observer upon this globe ; but it may be real. Be that as it may, all the planets move the same way that the sun seems to revolve, and therefore, the same way that its emanations move in their orbits.

Now by the influence of the rays of the sun moving with lightning speed in their orbital course, must the planets be all moved in one direction, since all their movements, both diurnal and annual, are governed entirely by the emanations of the sun, as we have seen. This is, doubtless, effected by the amazing influence

which, as we have upon a small scale demonstrated, that opposite polarities have upon each other, in inducing the particles of the electric stream to follow each other, and to move with them either atoms or masses of ponderable matter.

IMPORTANT QUERY ANSWERED.

"But why," it may be asked, "does not this tendency of electricity to control both atoms and masses of ponderable matter drag them outward, exactly in the line of the course of its orbital movements?" Because, as we have seen, if they were moved outward from their present position, they must become immediately minus, and be drawn back by the positive sun. Besides, were not this the case, the inward passage of the electric rays in their return, as we have before explained, to their source, the sun, being with a lightning speed as rapid as their outward emanation, may have a tendency somehow to neutralize the tangential force, and at the same time aid in the propulsion of the planets in their orbits, as the propelling force, if they have any, would be in the right direction.

MOTION OF COMETS.

* The eccentric movements of the comets are produced by the operation of the same laws as the movements of the planets. In the most distant part of their orbit, a thousand millions of miles perhaps from the sun, or even more, these wandering stars move very slow, and

in the arc of a circle almost immeasurable, having lost their charge of caloric and become minus. The sun being positive, and they deeply negative, it begins to exert an attracting influence over them. As that attraction increases continually, in proportion as the squares of the distance decrease, they move swifter and swifter until, as they approach the sun, they sometimes fly more than eight hundred thousand miles in an hour. At their perihelion, they are very near the sun, and become highly positive as they revolve half round in its intense blaze, and are propelled back again into the fields of space with the same lightning speed that they were attracted towards the great fount of all motion, by the repulsion of two positives.

HOW WONDERFUL.

In view of what has been said in the preceding chapters, how wonderful is the subject of electricity—how various and how magical are its agencies! It streams down in the vivifying rays of the sun—quickens and invigorates the sluggish pulsations of nature—preserves the warmth of vitality—works all the countless myriads of chemical changes—clothes the cheek with the blush of health—spreads a rich carpet of green over the landscape—dresses the forest in its foliage, and has, no doubt, a direct agency in the production and continuance of all the forms of both animal and vegetable life.

But there is a reverse to this picture. Not always

does it in the exhibition of its wondrous phenomena, put on an aspect of such blandness and genial benevolence, wreathing itself in sunny smiles. No! Its countenance sometimes gathers either mysterious grandeur or terrific fearfulness. Sometimes it streams upward from the poles, in splendid coruscations, and weaves a bright coronal of lambent light at the zenith. Sometimes it exhibits itself in the effulgence and evanescence of the meteor's flash, and the meteoric shower. Sometimes it leaps out from the dark foldings of the storm-cloud, darts downward through the gleaming tempest, and with a fearful energy which none else but God can wield, blasts everything it touches. Sometimes it flames athwart the heavens in the trail of the comet, as it speeds its erratic and lightning course, and makes the nations pale with forebodings. Sometimes it assumes the port, and majesty, and terror of the burning whirlwind—rushes forth upon the red wing of the Syroc, and sweeps with desolation the hot plains of Sahara. Sometimes it musters its almost omnipotent force in the deep caverns of the earth's centre, and makes the globe tremble and reel beneath the tramp of the earthquake, and melts rocks, and pours rivers of lava from the crater's mouth, and hurls enormous masses of blazing matter above the clouds, and upheaves mountains from the depths of the ocean, and piles them in the sky. SUCH ARE SOME OF THE WONDERFUL AGENCIES OF ELECTRICITY.

CHAPTER XXXIII.

ANIMAL MAGNETISM AND IMMATERIALITY OF MIND.

IN a work devoted exclusively to the subject of electricity, and its multiform agencies, a passing notice of the mysterious subject of Animal Magnetism and the Immateriality of mind could not very appropriately be omitted, since they both have a connection of some sort with the subjects that have been discussed.

TWO EXTREMES ERRONEOUS.

On the one hand it has been stoutly denied by some that animal magnetism is anything more or less than an arrant humbug, and, on the other, it has been as stoutly affirmed by a few that mind is an imponderable material, or electricity exhibiting one of its ten thousand modifications. Now, our object will be, in a very brief manner, to prove that these two classes of individuals are entirely incorrect in their opinions. Animal magnetism is not humbug, however much soever it may be sneered at, nor is mind material.

It might be expected that, in this connection, we should give a history of the first discovery of animal magnetism by Mesmer, and trace its rise and progress

to the present ; but we shall omit this, for want of room, deeming it, also, unnecessary, since it is so generally known.

To prove that animal magnetism is no humbug, we shall first state what we have seen, under circumstances where there could possibly be no collusion, no mistake, nor deception.

CONCLUSIVE EXPERIMENTS.

We have seen a deaf and dumb boy, about thirteen or fourteen years of age, unknown to the magnetizer, and having had no previous connection with him, placed upon a stage before an audience, there exposed to the steady gaze of the magnetizer for a few minutes, and, while he was looking about upon the audience with a smile of wonderment at what was passing, we have seen him suddenly fall asleep. After being put in this magnetic condition, we have seen him phrenologically affected by the magnetizer in a variety of ways, although it was utterly impossible that the boy should have known anything about phrenology, or, indeed, any other science. When the development of Benevolence was touched, he exhibited all the known indications of an extremely charitable disposition ; when Acquisitiveness was affected by the magnetizer, he exhibited selfish and miserly dispositions, directly the reverse of the former ; and when the organ of Motion was touched, he danced about the stage very nimbly.

CONDITION OF CATELEPSY.

We have seen the whole system catalepsized, and rendered rigid almost as marble. We have seen the eyes, in particular, so paralyzed, when wide open, that they would appear glassy and staring, like those of a wax figure, and in that condition we have seen a bright lamp held directly before the eye, without causing a wink or the movement of a muscle, which proved conclusively that there could be no deception, since no man, with his eyes open and awake, could possibly so control his muscles.

EXTRACTION OF TEETH.

We have seen a person put into the magnetic sleep, and in that condition have seen the attempt made, before a large audience, to extract a tooth—have heard it broken off with a snap, which resounded through the room—have seen the root dug out afterwards, and all this without a single scowl, or the movement of a muscle, or a single sigh, or groan, or symptom of pain. The brow of the sleeper was as calm and smooth during the whole operation as that of a sleeping infant.

APPLICATION OF LUNAR CAUSTIC.

Persons have been put into the magnetic sleep, and their eyes cauterized with lunar caustic, without the starting of a tear, while in that condition, or a wink,

or the convulsion of a muscle; and even, it is well authenticated, that limbs have been amputated while in the state of mesmeric unconsciousness.

LEGITIMATE CONCLUSIONS.

Now, what conclusions should we draw from all these facts? Shall we, with dogged pertinacity in unreasonable scepticism, deny the evidence of our senses? What other medium of ascertaining facts have we than our senses; and if we deny their evidence, do we not thereby discredit the very sources of all our knowledge? Those who disbelieve the evidence of their own senses are the humbugged, instead of those who trust in it. Animal Magnetism, then, is a sublime science, instead of being a miserable delusion.

IMPORTANT EXTRACT.

The following extract from a letter of John Neal, Esq., of Portland, Maine, to the Rev. Mr. Pierpoint, of Boston, Mass., is very appropriate in this connection :

"Seeing is believing with most people; with me, it is not. Notwithstanding my respect for my own eyes, and other senses, I am not willing to believe, in all cases, according to their testimony. If I did, I should believe that a straight stick becomes crooked by thrusting it into the water, and that men swallow half-pence by the handful, or perhaps thrust themselves inside out, and back again at pleasure.

"But while, on the one hand, I do not believe merely

because I see, or *think* I see; on the other hand, I dare not *disbelieve*, because I don't see. In other words, I do not presume to *disbelieve* what I cannot understand nor explain, for the same reason, that I do not *believe* always and at all times, according to appearances.

"Thus much to prepare you for the following, which I offer as a brief statement of facts: Five years ago I was neither a believer nor a disbeliever in animal magnetism, or mesmerism. The simple truth is, that I knew nothing about it. I had swallowed the report of Dr. Franklin—I had never met with the protest of Jessieu—and, like most people who had no reason for distrust or disquietude, I had taken it for granted that Mesmer was a madman or a knave, and his disciples and believers just of a piece with their master. Observe—I do not say that I *believed* this: but I had become possessed of a sort of notion that such was the historical fact. About this time I went to Providence with a view of satisfying myself about *mesmerism*. Just as I should have gone to Salem, in other days, to satisfy myself about witchcraft—to Providence, Rhode Island, I mean."

INVESTIGATION.

"There I entered into the inquiry patiently and carefully, and with a sort of professional anxiety to expose a miserable delusion. But I came away persuaded of the truth. I did not go to *scuff*—nor did I come away to pray. But I went to satisfy myself respecting

what, if true, was likely to open to us new views of the immaterial world. And I came away thoroughly convinced that, after allowing what you please for mistake, imposture, sympathy and imagination, there was at the bottom truth enough, and most alarming and important truth, to satisfy any reasonable inquirer, and to make further investigations *a duty*."

RECORD OF EXPERIMENTS.

"I did make further investigations. I tried experiments upon my own family—asleep and awake, in sickness and in health; and upon others, taking care that the subject I operated upon *should never know what was expected of him*, or of her. Having produced many of the simpler phenomena, I stopped, **afraid of tampering with the brains of healthy subjects, and I was not willing, with my limited knowledge of the science, to proceed further with the diseased than might be desirable for immediate relief.** I had produced a magnetic sleep, more or less profound, in several—cured the severest headaches, pains of the side, &c. &c., and on one occasion, the only time I ever made the attempt, had succeeded in affecting the stomach and bowels of a child, lying half asleep on the sofa.

"I had seen cases of clairvoyance, but, though inexplicable, and accompanied by strange coincidences, they were not *satisfactory*. I am aware now that, as it is with all strangers to these manipulations, I had expected too much, something different from what hap-

pened. Hence, I was disappointed. There was no opportunity for collusion, and there were many failures; but still I saw enough to convince me that there was a sort of spiritual vision—disturbed, to be sure, and very indistinct, like that of a dreamer who sees things half awake—but still a vision that might be turned to good account, after we should have become familiar with the conditions upon which it is exercised.”

FAILURES NO PROOFS OF HUMBUG.

“That failures occurred: that mortifications happened—failures which the manipulators and lecturers could not themselves account for: mortifications that were likely to throw an air of *barresque* over the whole subject, and completely unfit the lecturers for performing, and the public from judging, did not discourage me; for just such things had occurred with Franklin, and with Galvani—with Electricity and with Galvanism. Unaccountable failures happened in both, which neither could explain till the conditions of the atmosphere and the subject were better understood. It was enough for me if any *one* experiment was successful—fairly conducted—and incapable of being explained by any known laws, that I happened to be acquainted with, although ten thousand failures preceded or followed it. Meanwhile, I continued my investigations.”

SATISFACTORY FACTS.

“Briefly, therefore, allow me to state that I entertain no doubt respecting the prodigious augmentation of strength in the patient, at the will of the operator; respecting the clairvoyance of the subject; respecting his power of *perceiving* without the use of his eyes; of tasting and feeling with the organs of another; of the communication by *will* between the operator and the subject, without language, sign or touch; of the reality of the mesmeric sleep; of the power in a sleeper of seeing objects at a distance—perhaps at any distance—nor any doubt respecting any one class of the phenomena supposed to accompany the mesmeric manifestations. All this I believe, just as much as I believe in galvanism, electricity, pneumatics, or the powers of the alphabet; and, upon precisely the same evidence, that is, upon the evidence of my senses—after long and patient examinations, with all the powers of my understanding, after numberless experiments, conducted with the greatest possible care, and under circumstances where, trusting to nobody but myself, there was no opportunity for collusion, and—as I conscientiously believe—none for mistake or imposture.

“As I heartily approve the object of Dr. Collyer in establishing his Magazine, I have no sort of objection to the use I understand he desires to make of my testimony in the matter.”

CHAPTER XXXIV.

THE AGENT OF THESE WONDERS.

TAKING it for granted, that Animal Magnetism is real, and no trick or legerdemain, practiced to delude the credulous, what is the real agent that performs these wonders? What forms that chain of communication between the magnetizer, and the magnetized, by which the one can paralyze the muscles of the other, put him into a deep magnetic sleep, or control his motions, by means of certain manipulations, or, by simply looking at him; for there certainly must be a chain of communication of some sort, or there would be no such effects as we witness. We believe that this chain is formed by *electricity*, which is infused by the magnetizer into the system of the magnetized. What else is it—what else can it be? It certainly must be some agent. For never was there an effect without a cause, and electricity is the only agent known to us, whose operations would indicate, that it is capable of producing such surprising results. But how is it communicated? A solution to this problem can be found by examining the influence which mind exerts over imponderable matter.

POWER OF WILL.

What is the communicating agent between mind and the muscles of one's own system, for instance, by which the muscles obey the dictates of the will? Animal electricity doubtless, which, as we have seen, is inhaled with the oxygen, and which resides in the brain and nervous system; for these are nothing but a vast congeries of very fine blood vessels, and this would, therefore, not clash with the proposition, that electricity resides in the blood. When we will to extend an arm, the animal electricity obeys the dictate of mind, and irritates the extending muscles so that they perform the work they were bidden.

THE WILL CONTROLS THE MAGNETIZING AGENT.

Now, by this power, which the mind can exert over the imponderable principle, the magnetizer is enabled, by an energetic and concentrated effort of his will, to send the electricity of his own system into the system of another, and produce by the continued action of the will over the mysterious agent, all the phenomena, which we witness in magnetic somnambulism.

MIND NOT ELECTRICITY.

This animal electricity is, therefore, not mind, as some would affirm. It exhibits no governing will of its own, nor does it manifest thought or design in any department of its operations. But it is under the con-

trol entirely of mind, or will, in obedience with its own organic laws; for, where it is not controlled by man, it does the work of Deity and is governed by the will of the GREAT ETERNAL.

PREVIOUS REMARKS LONG PUBLISHED.

What precedes in these pages, upon the subject of Animal Magnetism, was published in 1843, in the first edition of this work. During the interval of fifteen years, many *new* facts, respecting this mysterious power, have been accumulated, which have established its verity as a science beyond controversy.

SPIRITUAL PHENOMENA.

Since that period, a new class of phenomena have startled the world. It is confidently claimed that disembodied spirits, who once dwelt on this sphere, now perform all the wonderful exploits of the mesmerizers, and control the medium and the clairvoyant as perfectly as Mesmer could, and make communications through them to the astonished world.

INTERESTING CONTROVERSY.

A warm controversy has lately sprung up between these modern spiritualists and some of the disciples of Mesmer. The latter declare that these pretended influences, manifestations and communications from the spirit land, are deceptive, and that they should all be referred to mesmeric principles and agencies without the intervention of spirits at all.

OUR OPINION.

We have witnessed the phenomena of both Mesmerism and Spiritualism, and have carefully and impartially investigated *both*. From our investigations we conclude, that the properly ascertained and well authenticated phenomena of both, *are correct*. If the *will* of the mesmerizer, *in* the body can control electricity, so as to get possession of the muscles, and mental faculties, and tongue of the medium and clairvoyant, there is no reason at all, why the *disembodied will or mind*, whose powers and knowledge of appropriate instrumentalities must be vastly increased, should not get possession, in the very same way, and by the very same agent, electricity, which is, as we have shown, under the control of will.

CHRISTIANS ALARMED.

These assumptions will doubtless very much alarm some timid Christians, who do not see the bearing of them upon their belief. But *why should they?* The Bible, which they revere, and *ought* to revere, is *full* of just such startling manifestations from the spirit-land.

SATAN'S EXPLOITS.

Satan is generally regarded, by orthodox theologians, as a disembodied spiritual existence, and yet *what has he done?* Why, by the exertion of his

mighty will, the Saviour was carried from the far distant wilderness to Jerusalem, and was "set upon a pinnacle of the temple" in the hour of his temptation.

Again, by another exertion of that mighty will, the Saviour was transferred bodily to "an exceeding high mountain," and, by mesmeric agency, or some other mysterious but powerful agency, "all the kingdoms of the world, and the glory of them," were made to pass in review before him. Now these are not *illusions*. They are *realities*, which are recorded by St. Matthew.

MANIFESTATIONS TO JOB.

In the temptations and afflictions of Job, Satan performed several equally wonderful exploits. He influenced the Sabeans to "take away Job's oxen and asses," and to "slay" all his servants, but a single messenger; he controlled the lightning of the clouds, and with it blasted his flocks; he influenced the Chaldeans to steal his camels; he brought up "*a great wind from the wilderness*," and therewith *crushed* the house of Job's "eldest son," and killed all his children; and finally, to cap the climax, he smote Job with sore boils from the crown of his head to the soles of his feet, and all but took his life.

By what agency did he do those wondrous exploits? Doubtless by the exertion of a powerful will, controlling the elements of destruction that did the work.

IN ACCORDANCE WITH OUR THEORY.

This is exactly in accordance with our theory, that mind, or its controlling power, *the will*, governs the imponderable principle, whether that *will* be embodied or *disembodied*.

THE BIBLE FAVORS THIS VIEW.

The Bible, too, favors this idea. In its language, the devil leads "the children of disobedience" "captive at HIS WILL," the very power, you will perceive, and the very agency, too, by which the mesmerizer controls his subject.

SNEERS ANTICIPATED.

Since we have alluded to the actual existence of a being called Satan, and gravely mentioned some of his exploits, as though they were *actualities*, we anticipate that some of those same spiritualists, the peculiar phenomena of whose belief we are defending from the assaults of its opponents, will burst out into a loud and derisive "*ha, ha, ha,*" and indulge in some witticisms about "*our great Almighty, club-footed king of hell.*" But why *should* they. They claim that disembodied spirits tip tables, elevate them from the floor, make them dance around the room, and a variety of other wonderful feats, and now why should they object to *these exploits* of a disembodied Satan? By so doing, they are just as unreasonable as those who

make assaults upon *their* belief, and bring the phenomena of their spiritual manifestations into discredit.

THEIR ANSWER.

"Oh, sir," say they, "the great revelator, Andrew Jackson Davis, has communications from the spirit-land, that there is no such being any where in the universe as Satan, and that there is no such place any where as the prison-house of hell, and all the spirits," say they, "through all our mediums assert the same thing."

OUR REPLY.

There are consummate liars *in* the body. May there not be just as consummate *disembodied liars*? We think there may be, and, indeed, that *there is*. In a very antiquated book, somewhat despised to be sure by some, but none the worse for that, we read that there is an old falsifier so outrageously untruthful, that he is called "*the Father of lies*," for his peculiar eminence in that line. Now, *who* knows but that he appeared to Andrew Jackson Davis on the "mount of vision," just as he did to our Saviour on that "exceeding high mountain" of old, called himself the spirit of the sage Swedenborg, and presented him with that wondrous *Magic Staff*, upon which he has leaned so confidingly ever since? This is just like one of the *deceptive tricks*, for which the hoary old falsifier of the universe is *peculiarly famous*.

PECULIAR PROMPTINGS.

Somehow it happens that the spirits, in their manifestations through most of the mediums, declare that there are no disembodied devils; that there is no hell; that the account of creation in Genesis is *all false*; and that everybody is freed from the shackles of priestcraft, and perfectly happy in the disembodied state.

Now, *who* can tell but that these spirits who make these statments are *disembodied liars*?

We are commanded in that antiquated book, which is so much sneered at by some, to "try the spirits."

Now, leaving all the other spirits out of the question, we will, by the test of *fact and of science*, "TRY" the one who presented the *Magic Staff* to Andrew J. Davis, and revealed to him that *Moses' account of the creation in Genesis is false and unphilosophical*. We do not believe this assertion of that spirit. And why? Because we can show that the assertion is *false* by the *real facts* in the case.

MOTIVES OF THAT SPIRIT.

If the spirit that presented to Andrew Jackson Davis upon the "Mount of Vision" that wondrous "Magic Staff," upon which he has since so implicitly relied, counterfeited Swedenborg, and in that counterfeit personification, made revelations to Davis, and if he was, indeed, that mighty apostate spirit, denomi-

nated "*the Father of lies*," he had a *definite object* in those revelations. Now, what was his motive? for he **is** the perfection of foxy cunning? *Why*, for example, should he wish to discredit the Mosaic account of creation? Because, forsooth, in that account his own vile acts and agencies in the garden of Eden are recorded. So almighty mean, malicious, and untruthful **is** he, that if he be not really *ashamed* of his own existence, yet he wishes, by himself and his agents, both embodied and disembodied, to *ignore and deny* that existence, so that he may the more effectually and successfully deceive the world, and mislead men to ruin.

Again, what motive could he, by himself or his agents, embodied or disembodied, have, *in denying the final resurrection of the body*? Because Jesus Christ, *his conqueror*, had, in our own proper human nature, by his own triumphant victory over this arch-apostate of the universe, *rescued* man from that *very death* which was entailed upon him by the subtle deceptions of that apostate—because he has become "the resurrection and the life," having actually, by virtue of his conquest over that dark spirit of malice, raised his own *real body from the dead*, since he says to the unbelieving, "handle me, for *a spirit* hath not flesh and bones as ye see me have," and because he has pledged the immutable veracity of the Eternal, that he will raise again *the actual bodies* of the whole human race.

Again, *why* should that "Father of lies" wish to

discredit the Mosaic account of the *deluge*? For the best of all reasons—because, if, by himself or his agents, embodied or disembodied, he admitted the *truth* of that account, he would thereby unwittingly admit the Mosaic account of creation, and he is altogether too expert and cunning a logician, or rather we might more appropriately say *sophist*, for that.

OUR MOTIVES.

We are not about to engage in a *theological discussion*. That would not at all comport with the design and character of this work. We intend simply to “TRY” that spirit (who made the revelations to Andrew Jackson Davis, that the Mosaic account of creation and the deluge is untrue,) by the facts and reasonings and logical deductions of SCIENCE, and incontrovertibly prove by *science* the *fulness* of his assertions and revelations, *spirit* though he be, for a *spirit* can be *tried* by the stern test of facts and logic as well as any *sophist* in the form.

In closing up this work, we make this “trial” because both Christians and infidels have, in some cases, drawn the conclusion from the first edition of this work, that it *avored* SKEPTICISM, whereas such was not our intention, and rightly understood, we trust that it will have directly the *contrary tendency*.

To be sure, we *fearlessly* investigate, whether in science, or theology, or logic, or in any department of knowledge, where we find subjects worth inves-

tigating, never trembling lest truth should be eclipsed or error made triumphant by intense examination. Any theory, or any system, or any opinion that will not bear the scorching rays of light, *ought to perish*.

IN ACCORDANCE WITH OUR DESIGN.

The investigation of the wondrous phenomena of creation, and the origin of our globe, is moreover in exact accordance with the object of our work—the examination of the origin of the *matter and its laws* with which we are acquainted. That investigation we shall commence in the next chapter.

CHAPTER XXXV.

GENESIS DEFENDED BY SCIENCE.

A SUBJECT more popular and attractive to the masses than the above, might, we are well aware, have been selected for discussion ; for the public taste has, in a measure, been vitiated by the too great prevalence of frivolous reading matter, but none more intrinsically *important* can be named among all the various topics of remark. For certainly, to no higher or nobler purpose can the powers of mind, the force of argument, or the developments of science be devoted, than to the defence of the word and unimpeachable veracity of Him who established all mental, moral, and physical law from the assaults which have from time to time been made upon them.

THE NECESSITY OF DEFENCE STRANGE.

Strange, indeed, is it, that there should be any necessity for such a defence ; but yet it is as *true* as it is *strange*. With the most plausible sophistries—with an almost unlimited invention of petty quibbles and objections—with an untiring industry, worthy of a better cause, sometimes even with a rankling, spiteful, and burning malice, the very incarnation of the pit, have that word and veracity been assailed.

ASSAULTS AIMED CHIEFLY AT GENESIS.

But against no point of the citadel of truth, have all these resources of opposition and error been marshalled with more ingenuity, or urged with greater vehemence, or hurled with more dexterity and bitterness, than against the Mosaic history of creation and the deluge, and the testimony of inspiration respecting the final conflagration of our system.

FANCIED SUCCESS.

And such has sometimes been the fancied success of these assaults, that a loud shout of triumphant exultation has rung through Christendom, as though the impregnable walls of that citadel had been battered down ; and the champions of truth have sometimes turned pale, and felt the anchor of their hope giving way and trembled for the consequences, and have, under the influence of such fear, sometimes made unnecessary and unjustifiable concessions, and thereby in a measure weakened the positions which they should have maintained unflinchingly, without one single iota of compromise, keeping ever before them in characters bright as the pencillings of the sunbeam, "*Truth is mighty and will prevail.*"

OUR DESIGN.

With unlimited confidence in the immovable stability and everlasting endurance of this great proposition, we shall proceed to defend the truth of the Mosaic

history of creation and the deluge, from the assaults which have been made upon it; and shall attempt to show wherein injury has been sustained, by the zealous but ill-advised and misdirected efforts of the champions of revelation.

PRELIMINARIES.

That we may proceed understandingly and systematically to the performance of our task, we will first mark out the whole field of controversy, and define its boundaries, and reconnoitre the precise position of opponents (for we shall recognize the *trial* of that false spirit through his agents), and describe their armor, and the weapons in which they trust for offensive and defensive warfare.

TWO DIVISIONS.

Marshalled in two grand divisions, the enemies of revelation are arrayed in hostility to the Mosaic history of the origin of the earth, the deluge, and the prophecy respecting the conflagration and re-formation of our globe, mainly upon the ground or within the field of reason and science, and upon that ground or within that field we shall meet them.

FIRST DIVISION.

The champions of a rank and bold infidelity head one division. They utterly deny both the authenticity and the literality of Genesis and the Bible generally, be-

cause, as they affirm, it is inconsistent with reason—because there are discrepancies in the account of creation itself, which cannot be satisfactorily explained and reconciled, and because it conflicts, as they affirm, with all the known facts of science and Geology.

SECOND DIVISION.

The advocates of the dreamy fantasies of Swedenborg head the other division, and, although *apparently* discarding the bold assumptions of infidelity, as untrue, they are, nevertheless, equally enemies of the truth, and inculcate a less open and reckless, but more subtle and dangerous infidelity, inasmuch as its plausible sophistries are much better calculated to mislead and deceive the unwary.

THEIR ADMISSIONS.

They admit, it is true, that Genesis is authentic, but yet entirely fritter away its truth, by denying its *literality*. They affirm that there was no such creation and deluge, as a literal construction of the history would indicate, but that the first eleven chapters of Genesis is an *allegory*, incomprehensible to the mass of mankind—that the key to this allegory was lost to the world at the confusion of tongues—that Frederic Emanuel Swedenborg has found it, a special revelation having been made to him respecting it, and that he and his initiated followers can alone unlock the hidden arcana of its mysteries.

WORTHY OF ATTENTION.

It is, furthermore, worthy of record and remembrance, that the champions who head this division of the forces of error use precisely the same arguments against the *literality* of Genesis, that the champions who head the other wing of opposition to truth, do against its *authenticity*. And wherein, then, is the difference, in reality, between them? There certainly is none, except that the infidelity of Swedenborgianism is the subtlest and most dangerous of the two.

LATER REVELATIONS

In just accordance with the inference above, Fred-eric Emanuel Swedenborg has become *wiser* in the spirit-land than he was in the form, and has communicated that increased wisdom in a revelation to the favored Andrew Jackson Davis, probably when he made him the magnificent present of that wondrous "*Magic Staff*," on the "Mount of Vision." By this later revelation of the spirit of the disembodied Swedenborg, through Davis, he shows conclusively that he has gone clean over to the *first battalion* of opposers, and now discards Genesis altogether as the production of designing priestcraft. Now, who does not see in all this nonsense the dodging of an artful and lying sophist, like the arch-apostate?

We will here give a brief outline of the argument, both against the authenticity and literality of Genesis,

and then attempt to show that their reasoning is false and inconclusive.

OUTLINE OF ARGUMENT.

They affirm that there are discrepancies in the Mosaic account of creation itself, which cannot be reconciled, inasmuch as it is said that light was created upon the *first* day, whereas the sun was not, according to the same account, created until the *fourth* day, and they therefore affirm that the whole history is unphilosophical, since light could not exist before the sun—that, if the record of the six days' creation be intended to be regarded as *literal*, the world is not, according to that history, but about six thousand years old, which, as they affirm, conflicts with the known and acknowledged facts of Geology, by which it is proved to be myriads of ages more—that it is contrary to every principle of reason and philosophy to suppose that the deluge should so overflow the whole earth, as to submerge it beneath the water fifteen cubits below the tops of the highest mountains, and that the entire history is, therefore, altogether unworthy of belief, if regarded as anything but an ingenious allegory.

OUR PROPOSITION.

Now, in answer to these objections of Swedenborgianism and infidelity, we shall assume the proposition, that the history contained in the first eleven chapters of Genesis is both *authentic* and *literal*, and that, if the

original Hebrew be properly construed and understood, that history does not conflict *at all* with the known and acknowledged facts of geology, nor with any sound principle of reason or philosophy.

UNWARRANTABLE ADMISSIONS.

We are aware that, in thus assuming that the history is both authentic and strictly literal, we object to certain admissions which have been made by the champions and defenders of the Mosaië account. But, in justification of such a course we have reasons to urge, the validity of which forcibly impress our own mind. We think those admissions have been very incautiously and injudiciously, as well as unjustifiably made, and have, in many cases, materially weakened the defence of those champions, and unnecessarily, in some cases, given their opponents the decided advantage in the discussion.

PRINCIPLES OF INTERPRETATION.

It is a settled principle of interpretation, we believe, and one perfectly correct, that, in an apparent narration of facts, if there be nothing preceding it, or in the narration itself, which indicates a figure, a parable or an allegory, it is uniformly to be regarded as *literal*. Any other rule would inevitably introduce complete confusion and perplexing uncertainty into the medium for the conveyance of thought or of intellectual impressions from mind to mind, and every man, however

wild and crazy in his notions of things, would accommodate the language to his own mental vagaries, and build upon it his own peculiar fabric of mysticism, having his own peculiar key to unlock its meaning.

RULE OF INTERPRETATION.

It is then, we say, an established rule of interpretation, that every statement, purporting to be a statement of facts, should be construed literally, according to the comprehension of unsophisticated minds, unless the narrator intimates, by either the text or context, that he is uttering or writing parables or allegories.

APPLICATION OF THE RULE.

Now let us apply this rule to the matter under discussion. There is no indication whatever, in the Mosaic account of creation, of any thing but a plain, straight-forward narrative of events, which actually and literally transpired, exactly in the order in which they were described. Any other hypothesis would create confusion in our ideas—would send the honest inquirer after truth afloat upon a dark and wild ocean of doubt and uncertainty, without compass, or rudder, or helmsman.

SOMETHING CONCLUSIVE.

There is something, for illustration, directly to the point in the matter under discussion. When it is affirmed in the narrative of Genesis, that "the evening

and the morning were the first day," we must either regard it as a single revolution of the earth upon its axis, which constitutes a literal "evening and morning," or else the moment we depart from its strict literality, and admit that the days spoken of might be each of them many hundreds or many thousands of years or ages, we can then set no boundaries at all to the extent of the figure, and at once lose sight of all reliable landmarks in the discussion.

PLAUSIBLE OBJECTION.

The objector may then very plausibly and justifiably declare that we have no authority whatever to assert, for the sake of convenience, or to help ourselves out of a dilemma, that a part of the narrative of Genesis is figurative and a part literal. He may very justly require that we should make the narrative either *entirely figurative* or *entirely literal*, and not make it the one or the other, just so far as it may happen to suit our purposes of convenience. We cheerfully, and *must*, in honesty, concede that he is right in the requirement.

NOT TOO MUCH CONCEDED.

But it may be asked by some of the champions of revelation, whether, by assuming this position of strict literality, we do not, in fact, deny the well attested

facts of Geology. Not at all. For we consider a well-authenticated and indisputable fact of Geology just as worthy of implicit belief, as an equally well-authenticated and indisputable fact of revelation ; for both facts had their origin in the same reliable source, and both emanated from the same fountain of eternal truth.

ORIGIN OF GEOLOGY AND REVELATION IDENTICAL

The same Being, whose hand, in the exertion of its resistless Omnipotence, formed and moulded each geological stratification of the globe, in its respective order, gave utterance also to each recorded fact and event mentioned in revelation. Both geology and revelation must, then, of necessity harmonize perfectly, and instead of conflicting, as the sceptic affirms, must mutually corroborate the truth of each other. Instead, therefore, of attempting in this discussion to array revelation against the facts of science, or science against the facts of revelation, we shall regard them both as equally true and equally worthy of implicit confidence, and shall use them as mutual elucidators of each others meaning.

GOD QUITE AS WISE AS MAN.

Now, one thought more upon the subject of strict literality, and we will dismiss the subject. The great fountain of all wisdom and knowledge must be quite as felicitous in his choice of language to convey his

meaning, as the most critical and acute philologist. He uses no word at random, or loosely and ambiguously when conveying his thoughts and purposes, even though he conveyed them *through* the mind of another. Every phrase signifies precisely what it was *intended* to signify. He must, also, know perfectly the mental calibre and strength of understanding of those to whom he condescends to communicate his thoughts. When, for instance, he made a revelation to man, he knew precisely what man was, and of course he made it to be *understood* by man, or else it was no revelation at all; for that which purports to be a revelation, must, of course, be communicated in language *to be understood* by those to whom it is addressed, or else it is *no* revelation certainly, but a tantalizing deception—a mockery, to which no pure and benevolent being would stoop.

VALID CONCLUSION.

We draw this conclusion, then, from what has been said, that, when the Deity made a plain statement of certain facts, as those regarding creation, he expected, doubtless, that they would be received *as* facts addressed to the comprehension of common minds. Any other supposition would be a libel upon the fountain of all wisdom and knowledge.

CHAPTER XXXVI.

CORRECT INFERENCE.

WE must, from our deductions, regard the Mosaic account as *literally true*, and proceed, as best we can, to show how the facts of geology can be reconciled with that account, or that account with the facts of geology ; for we hold it to be a proposition, capable of incontrovertible proof, that every fact made known by Deity in the revelation of his creation has its corresponding fact in geology, which exactly coincides, and must *of necessity* exactly coincide with it, whether, with our limited research and finite powers of mind, we can discover that coincidence or not.

CRITICAL DEDUCTION.

We will now commence a careful and critical review of the history of creation in Genesis, and examine it step by step to ascertain its real meaning, bringing in the aid of science and reason to explain and elucidate its extreme brevity.

CREATION.

When it is said that—"In the beginning God created the heavens and the earth," it is generally

understood by the phrase that the Deity then *originated from nonentity*, the *material* out of which our system was formed.

ASSUMPTIONS IMPOLITIC.

Now, in a discussion where important truths are at stake, we regard it as a very inexpedient policy to assume that anything is a positive fact, past controversy, contradiction, or doubt, if it be at all doubtful. Such an unwise course only weakens the position it was intended to strengthen, and gives an opponent of real truth a decided advantage. Such has been the case, in our estimation, with regard to the first verse of Genesis. The original Hebrew word, translated "*created*" in that connection, does not necessarily signify an absolute origination of material from nothing, for the word is used elsewhere to signify the modification of material which already existed, and we shall not, therefore, for the reasons before stated, so consider it, since such an assumption is not at all essential to the validity of our argument.

CONCLUSION.

That material, we are willing to concede, might, from aught that appears in the Hebrew idiom, have existed in other forms for untold ages previous to this grand event, and might, for aught we can say to the contrary, have undergone ten thousand various trans-

formations before, in accordance with the phenomena of ceaseless change which astronomy reveals.

NOTHING ESSENTIAL CONCEDED.

In conceding this point, we concede nothing worth controversy to the objector. It is entirely immaterial to our argument whether it were then originated, or whether it had undergone innumerable changes and modifications previously.

WHAT WE DO NOT CONCEDE.

Let it not, however, for a moment be understood that in making this concession we concede also that the same material might have existed *eternally* and been unoriginated; for we admit no such thing. There was a period of time in the untold ages of the past when it must, *in the very inherent necessity of things*, have been originated from nonentity. For it could easily be shown, by a process of incontrovertible reasoning, which, however, is foreign from the present discussion, that there could not possibly exist together two co-eternal, self-existent essences; so that, if *mind* be eternal, *matter* cannot be, and must, therefore, of necessity, be under the control of that eternal mind, and must have been originated.

"CREATE" DOES NOT ALWAYS SIGNIFY ORIGATION.

The Hebrew word which is here translated "create," is used in several other parts of the Old Testament to *modify* matter already existing.

SIDEREAL CHANGES.

As we shall be required, in the proper illustration of our subject, to take notice of the various changes which are going on among the systems of the starry heavens, it may not be inappropriate here to make the passing remark, that the very fact of those changes, proves that matter is not eternal, for, if it were it would not change, and that the self-existent and eternal Essence which produces and controls these changes *must* himself be *unchangeable* and everlastingly the same.

STARTLING PHENOMENA.

We will now glance at some of the startling phenomena of mutation which Astronomy reveals, so that we may call in the important aid of analogy to the defence of the positions, which we may, hereafter, assume. And here we will introduce several facts from Burritt's Geography of the Heavens, from which we design to draw certain conclusions. They relate to the wonderful disappearance and re-formation of fixed stars or suns.

LOST STAR.

"Two hundred and fifty years ago, a bright star shone, five degrees north-northeast of the star Caph, in the constellation of Cassiopeia, where now is a dark void!

"On the 8th of November, 1572, Tycho Brahe and

Cornelius Gemma saw a star in the constellation of Cassiopeia, which became, all at once, so brilliant, that it surpassed the splendor of the brightest planets, and might be seen even at noonday! Gradually, this great brilliancy diminished, until the 15th of March, 1753, when, without moving from its place, it became utterly extinct."

APPEARANCE OF THE PHENOMENA.

"Its color, during this time, exhibited all the phenomena of a prodigious flame—first it was of a dazzling white, then of a reddish yellow, and lastly of an ashy paleness, in which its light expired. It is impossible, says Mrs. Somerville, to imagine anything more tremendous than a conflagration that could be visible at such a distance. It was seen for sixteen months."

OPINIONS OF ASTRONOMERS.

"Some astronomers imagined that it would reappear again after 150 years; but it has never been discovered since. This phenomena alarmed all the astronomers of the age, who beheld it; and many of them wrote dissertations concerning it."

CONFLAGRATION OF ANOTHER STAR.

"Another instance of the same kind was observed in 1604, when a star of the first magnitude suddenly appeared in the right foot of Ophiuchus. It presented, like the former, all the phenomena of a pro-

digious flame, being, at first, of a dazzling white, then of a reddish yellow, and lastly, of a leaden paleness; in which its light expired. These instances prove that the stars are subject to great physical revolutions."

PROF. VINCE'S REMARKS.

"Rev. Professor Vince, one of the most learned and pious astronomers of the age, has this remark: The disappearance of the stars may be the destruction of their system at the time appointed by the Deity for the probation of its inhabitants; and the appearance of new stars may be the formation of new systems for new races of beings then called into existence to adore the works of the Creator."

CONTINUAL CHANGES.

"Thus, we may conceive the Deity to have been employed from all eternity, and thus he may continue to be employed for endless ages; forming new systems of beings to adore him; and transplanting beings already formed into happier regions, who will continue to rise higher and higher in their enjoyments, and go on to contemplate system after system through the boundless universe."

OPINION OF LA PLACE.

"Laplace says: As to those stars which suddenly shine forth with a very vivid light, and then imme-

diately disappear, it is extremely probable that great conflagrations produced by extraordinary causes take place on their surface. This conjecture, continues he, is confirmed by their change of color, which is analogous to that presented to us upon the earth by those bodies which are set on fire, and are, then, gradually extinguished."

OBSERVATIONS OF DR. MASON GOODE.

The late eminent Dr. Mason Goode observes, that "worlds and systems of worlds are not only being perpetually created, but are also perpetually disappearing. It is an extraordinary fact, that, within the period of the last century, not less than thirteen stars in different constellations seem to have totally perished, and ten new ones have been created. In many instances it is unquestionable that the stars themselves the supposed habitations of other kinds and orders of intelligent beings, together with the different planets, by which it is probable they were surrounded, have utterly vanished, and the spots, which they occupied in the heavens, have become blanks!"

OUR DESIGN.

Aside from the consideration of the grandeur and sublimity of the ideas contained in the above extracts, we have been influenced in their selection for the sake of certain practical conclusions, relevant to the subject under discussion, which we design to draw from the interesting and startling facts which they unfold.

PHENOMENA OF BURNING STARS EXAMINED.

Those stars, whose wonderful disappearance is spoken of, were suns, and, reasoning from analogy must conclude that they were not isolated ; that they shone not on empty space in vain, but that they were surrounded, like our sun, with their attendant retinue of worlds or opaque bodies, which revolved around their central and guiding influences.

Now when any one of those fixed stars or suns appeared from the heavens—when, for instance, in the constellation of Cassiopeia expired in a remarkable manner, what became of the planets which were controlled in their movements by its light and heat? Why, they doubtless perished with it ; for mere matter must, when the controlling element of life is withdrawn from it. For should our sun, for instance, be suddenly blotted from the heavens, the order and regularity of the whole solar system would be at once destroyed, and all the planets which compose that system would rush headlong to anarchical chaos.

IMPORTANT QUERY.

Another important query here naturally suggests itself in connection with the subject under discussion. When the star in 1572 increased so immensely in size and brilliancy, as to present the appearance of a tremendous conflagration, what supplied the fuel for the conflagration, which was so intensely luminous

be apparent to astronomers of our globe more than forty millions of millions of miles distant? The circumstances of the case press with great urgency for a definite and satisfactory answer; for never was there, be it remembered, an *effect* without a *cause*, or a *cause* without an *effect*—never was there a fire without fuel or combustible materials of some sort to make it.

THE ONLY APPROPRIATE ANSWER.

The only answer to this question which we can conceive as at all appropriate or reasonable, is, that the law of attractive and repulsive force, which kept the opaque worlds that surrounded that star so perfectly balanced in their several spheres up to the time appointed for its destruction, was suspended by the same Almighty power that enacted that law, and then, those planets, no longer balanced in their orbits, must have rushed into the great central fires of their system, and been buried beneath its ocean waves of flame thousands of cubits deeper than was this globe of ours beneath the waters of the deluge of Noah.

INEVITABLE RESULT.

The necessary result of such a grand catastrophe would have been a vast increase of the size of that star, and would have produced a conflagration so prodigious as to be noticed some forty millions of millions of miles distant by Tycho Brahe, the astronomer of our globe, who observed it.

QUERY OF AN OBJECTOR.

But some one may here ask the question, whether that sun was hot enough thus to burn up its dependent worlds, since some philosophers assume that the suns or fixed stars of the universe are nothing more than opaque bodies themselves, surrounded by a luminous atmosphere?

ANSWER TO THIS QUERY.

To answer this question satisfactorily, as we imagine can easily be done, we must appeal to *facts*, which are the only safe criteria whereby to form a judgment. It was estimated, for instance, by Sir Isaac Newton, and other astronomers of the day, who carefully computed the elements of the celebrated comet of 1680, that it approached only within *one hundred and thirty thousand miles* of the surface of the sun, and yet that it was heated, even at that distance, *two thousand times hotter than red hot iron*—hotter, indeed, by several degrees, than was sufficient to burn up and completely vaporize any known substance within the compass of our observation.

If then, at the distance of 130,000 miles from the surface of the sun, the heat be so intense as to burn up and vaporize any substance with which we are acquainted, even including the rock-ribbed hills of granite, what must have been its effect upon worlds plunged beneath its mountainous waves of fire? Why surely, just what Tycho Brahe saw in 1572—a conflagration so enormous, as to astonish astronomers *millions of millions of miles distant*.

CHAPTER XXXVII.

IMPORTANT QUERY.

WAS that star, which was lost in Cassiopeia, *large* enough to engulf its dependent worlds within its capacious vortex of ethereal fire? By analogy we infer that it was.

ANSWERED BY A SUPPOSITION.

Had the appointed time now come, for instance, for the dissolution by fire of our system, and for the melting and burning of our elements by fervent heat, how could the great event be accomplished? It is a known fact, the result of accurate mathematical calculation, that the aggregate magnitude of all the primary planets with their attendant satellites, put them all together, would be *many thousand times less* than the bulk of the sun.

To acquire, so far as possible, an adequate idea of its immense comparative bulk, and to fill the mind, in some measure, with the grandeur of the subject, we will here quote a remark or two from Burritt.

QUOTATION FROM BURRITT.

"Of a body so vast in its dimensions, the human mind, with all its efforts, can form no adequate con-

ception. The whole distance between the earth and the moon would not suffice to embrace *one-third* of its diameter." "Were the sun a hollow sphere, perforated with a thousand openings to admit the twinklings of the luminous atmosphere around it—and were a globe as large as the earth placed at its centre, with a satellite as large as our moon, and at the same distance from it as she is from the earth, there would be present to the eye of a spectator on the interior globe, a universe as splendid as that which now appears to the uninstructed eye—a universe as large and extensive as the whole creation was conceived to be in the infancy of astronomy.

LARGE ENOUGH TO ENGULF THE WORLD.

It must be apparent then, from what has been said, that the sun is large enough to engulf all the planets that surround it, ten thousand times ten thousand fathoms beneath its ocean waves of etherial fire. By analogy we infer, then, that the star which burnt out in 1572 was large enough thus to swallow up and devour its whole retinue of dependent worlds.

MUTATION NOT ANNIHILATION.

Now, if fixed stars have been burnt out, and have disappeared from the heavens, leaving their places a blank, as is a well-attested fact of science, and if, as is very probable, these dependent worlds have supplied the fuel for that immense conflagration, what has

become of the material of those suns and worlds? Was it annihilated? From analogy, we conclude not. Whenever there is a destruction, for instance, of any combustible material by fire, annihilation is not a necessary consequence. Not a single particle of its resulting elements is lost. They all exist somewhere, either in smoke, or in the gases, or in ashes.

VAPORIZATION DOES NOT DESTROY.

When water becomes united with heat, it passes into an aeriform condition, and is magnified some eighteen hundred or two thousand times. Each minute particle forms a little vesicle or minute balloon filled with caloric, but still there is no diminution of its substance by the change. You have only to abstract the caloric to condense it into water again, having the same bulk as it had before vaporization.

APPROPRIATE CONCLUSION.

Now, what is the rational conclusion with regard to the star of 1572, or that of 1604, in the right foot of the constellation of Ophiuchus, or of that of any other star which has thus burnt out and disappeared? Why that the opaque bodies which surrounded them were precipitated into them—were vaporized by their intense heat—the material of each was united with the other, as is always the case with caloric and opaque matter when brought into contact in certain proportions, being vaporized, it became vastly magnified and aeriform in its character, and disappeared

from its former fixed location, and floated away through space to mingle, probably, with the nebulous matter or irresolvable star dust of the skies, which is, doubtless, the faintly luminous and vaporized material of burnt-out worlds and suns, held there in chemical union by some mysterious bond until, by the all-creating fiat of the Almighty, it shall be ordered to some appointed spot of the universe, be there separated—the opaque matter by itself, and the caloric, which holds it in a state of vaporization, by itself—and there be reformed by the Omnific Word, which everywhere controls it, into another solar system, taking its place again among the clusters of some one of the constellations.

Is this mere fiction, or sportive ideality? Is there, in fact, any other rational solution of the question with which we started? Is there any other more satisfactory theory to account for the phenomena of the *luminous nebulae* or irresolvable star-dust of the skies, than that it is the vaporized material of burnt out suns and worlds held in an aeriform condition by caloric, the great vaporizing agent, and rendered slightly phosphorescent or luminous in its appearance, by the excess of the caloric of each sun over the bulk of its dependent worlds, as we have seen is the case, by a comparison of the solar system; for were the material of our sun and worlds to be vaporized and held in chemical union, the caloric so far exceeds in bulk the opaque matter that the vapor must *necessarily* be *luminous*.

PHENOMENA OF GENESIS.

Now, if in such matters we have any right at all to draw conclusions from scientific analogies, and we believe we have, for God invites investigation of his works, then we conceive that this is precisely the phenomena which is described in the second and third verses of Genesis. Mark the language of that record. It was true, and will be found, scrutinize it as closely as you may, to coincide with all true science.

"The earth was without form and void," that is, there was nothing but perfect vacuum, so far as mere matter is concerned; where it now hangs, "darkness was upon the face of the deep." Yes, the vast space now occupied by our solar system might well be called a "deep"—a "void"—or "vacuum"—a blank ocean, whose immensity can scarcely be fathomed or comprehended by finite minds.

IMMENSE SPACE OCCUPIED BY OUR SYSTEM.

Sirius, the bright star in the constellation Canis Major, is considered the nearest fixed star to our earth, and yet its distance is computed to be twenty millions of millions of miles from us—a distance so great that a cannon ball, flying at the rate of nineteen miles a minute, would be two millions of years in passing over the mighty interval, while sound, moving at the rate of thirteen miles a minute, would not reach it in less than three millions of years.*

This distance, however, is only a part of one of the radii shooting out from the centre of this ocean of space occupied by our system, the whole diameter of which must have been more than forty millions of millions of miles, and whose cubic bulk must have been past all finite comprehension. "Darkness was upon the face of this deep," as there was nothing throughout the whole boundaries of its "void," or vacuum to illuminate it. And the important hour had now come to fill this "void." "The Spirit of God moved upon the face of the *waters*." This is the language of our translation, with which, from careful investigation, we are not entirely satisfied. The Hebrew of the original will bear a different construction. We may safely and appropriately render it, "The Spirit of God brooded upon the face of the vapors;" that is, upon the vaporous masses of matter that had been decomposed by the convulsion of some previous destruction, and reduced to a chaotic state.

IMPORTANT PROBLEM

Now where was the material which constituted these vapors? Was it in the void spoken of? I apprehend that it could not have been. Nothing was there but a blank—a "void," throughout whose vast extent "darkness" rested. But the material which constituted these vapors was something, and had a location.

Now was it not the vaporous and chaotic elements of burnt-out systems, since the material of lost suns
~~— necessarily be~~

and worlds must exist somewhere in space in a state of decomposition, unless, when they so wonderfully disappeared, they were absolutely annihilated, for which hypothesis we have no proof at all? Was it not the material of the floating and irresolvable nebulæ? By the investigations we have made, we prefer this as the most rational and philosophical hypothesis—the one best calculated to rescue the Mosaic history from the difficulties which surround it, and defend it from the subtle objections which are urged against it.

OMNIFIC MANDATE.

Upon these vapors "the Spirit of God moved" with energizing power. Then was issued that omnific mandate, which Longinus and others have so much admired for its sublimity, grandeur, and brevity: "And God said, let there be light, and there was light." Light, where? Why, light diffused through that "deep" where "darkness" dwelt before. Was it there previously, or its material. No, for the space was a "void" previously. It must either have been originated then or been *ordered* there. It certainly was not *originated* then, for "the Spirit of God had just moved upon a" material which existed. The rational conclusion then is, that when the "Spirit of God moved upon the vapors," they were the luminous, nebulous masses of the sky, and when "God said, let there be light, and there was light," so much of that luminous stardust as had been "moved" upon, energized and sepa-

rated—obeyed instantaneously the will of its sovereign, and filled the “void” of the “deep” with its luminousness, upon whose “face” “darkness” had brooded before.

NOT THE SUN.

This light, certainly, which God then spoke into existence was not the sun, for the sun was not created until the fourth day, an account of which is contained in the fourteenth, fifteenth and sixteenth verses of the same Chapter.



CHAPTER XXXVIII.

IRRESOLVABLE NEBULÆ.

THE irresolvable nebulæ, of which we spoke in the last chapter, are by some mysterious attraction mostly drawn to a certain section of the universe and there form a luminous belt or zone of enormous circumference. These may as we have already observed, be the decomposed material of lost systems, "out of which," as Herschell very properly remarks, "nature," or we would rather say Deity, "elaborates *new suns and systems*." It is also remarked by Herschell, that "several nebulæ are formed by the dissolution of larger ones, and that many of this kind are detaching themselves from the Milky Way."

LOGICAL CONCLUSION.

Now this is precisely such a phenomenon as was presented to the universe, if our theory be correct; at the glorious spectacle at which "the morning stars sang together, and all the sons of God shouted for joy." So much of the *luminous nebulæ, or light*, as would fill the immense "void" where our system is located, was "detached" in the language of the extract, and ordered into that space, where "darkness" dwelt before, and was there "elaborated into a new sun and system."

OBJECTIONS OF CAVILLERS VANISH.

And now, before this theory, what becomes of the objection, upon which infidels have laid so much stress, that *light* could not exist before the sun. It vanishes in a moment.

So, then, here upon the *very ground*, where the objector to the authenticity and literality of Genesis had proudly taken his stand, confident of triumph, the *truth*, never foiled—mighty to conquer—will prevail over him. This very objection itself can be used against him with irresistible keenness, and, “like Damascus blades without their hilts—all edge”—will wound him wherever he seizes hold of it.

MEANING OF “AOUR” AND “MART.”

The word in the original Hebrew, translated “light” in the third verse of the first chapter of Genesis, is different altogether from that translated “lights” in the fourteenth, fifteenth, and sixteenth verses of the same chapter, and which has reference to the sun, moon, and planets, created upon the fourth day. The two have a different signification. The word translated “light” in the third verse is “*aour*” in Hebrew, “*phose*” in Greek, and “*lux*” in Latin, which signifies *light in a state of diffusion* rather than light in a body; while that, translated “lights” in the fourteenth, fifteenth, and sixteenth verses, is “*mart*” in Hebrew, “*phostares*” in Greek, and “*luminares*” in Latin, which signify “*enlighteners*,” or light condensed into a focus, or collected into a body like the sun.

ALL DISCREPANCY DISSIPATED.

Now all the supposed discrepancy of Genesis vanishes in a moment before a proper understanding of its real meaning. The light of the third verse is not an "*enlightener*" in the same sense of "*mart*"—that is, not light in a body, shedding from a concentrated focus, its rays upon other bodies or other matter, but simply light in a diffused state, which it appears to us, can be no other than the floating nebulous masses of luminous vapor or star-dust as we have supposed, and this is the "*aour*" with which the Omnific Word filled the "deep," where darkness before brooded, when "God said, let there be light and there was light."

DISPOSITION OF THE "AOUR."

What now becomes of the luminous matter, thus ordered into the space, occupied by our present Solar System? The very next verse will answer the question, and bring us one important step nearer to the consummation of our argument, and will, further, prove conclusively, that we need no better guide, in this discussion, than the word itself, properly understood.

IMPORTANT ANALYSIS.

After God had said, "let there be light," and the great "void" of the "deep" had been filled up with it, he next does *precisely* what we should suppose he would, if our theory be correct.

"And God saw the light that it was good" — in amount and quality just as he would have it, and just as he had ordered it; "*and God divided the light from the darkness.*" Now what does this remarkable expression mean; for it has a *definite* meaning, and a meaning very different, we imagine, from that generally ascribed to it? Was a sun then created? No. Was light collected into a body? No; for that was not done until the fourth day. But a *separation* is produced. Now, a separation of what? Why of "*light*" from "*darkness.*" But what does this singular expression mean? "Light" has no more communion or union with "darkness," in the common acceptation of the term "darkness," than "Christ has with Belial." There certainly can be no chemical combination whatever between the two, simply in themselves considered. For where light is, there is no darkness at all, and can be none—as the term darkness is generally understood. What, then, does this *division*—this *separation* mean, for, although Moses has been sneered at, as being ignorant and unphilosophical, yet it may eventually be satisfactorily proven, that he was far more philosophical than his arrogant deriders.

APPROPRIATE SOLUTION.

Why, if the material, with which the "void" of the "deep" was filled, was the nebulous vapor of the skies, and if that nebulous vapor was the material of suns and worlds combined in chemical union by conflagra-

tion, as we have supposed, then is there a wonderful, most beautiful and philosophical appropriateness in the language, and the critical accumen of Moses, and through him, of Eternal Wisdom, is fully justified and defended against the profane witicisms and blackguard sarcasm of self-opinionated fools.

When "God *divided* the light from the darkness," he simply dissolved the connection, or chemical union, which conflagration had formed between the two, by abstracting the *caloric* from the *dark opaque* material, with which it had been combined. What followed? Why the vapor ceased to be vapor any longer, as is always the case when caloric is abstracted from it, and so the liberated material returned to its native dark state, and was, of course, immensely condensed from its gaseous condition.

That is the only "division indicated by the passage, which we consider as at all appropriate, and we are unwilling to dishonor the great fountain of all wisdom and knowledge so much, as to concede for a moment that he cannot use language quite as appropriately as the very best and most learned of his puny and short-sighted revilers.

The very original Hebrew word translated "divided," indicates just such a chemical decomposition as we have supposed, for the Lexicon of Gessenius, in giving its definitions of the word "*divided*" refers to this very verse, and construes it to mean "*a separation of things mixed together or united.*" So that the Mosaic history is care-

fully and wisely guarded against the puny assaults and malicious misinterpretations of its adversaries.

THE SUN NOT YET MADE.

Was a sun now made of the caloric or light? Not yet. It was still "*aour*"—still light unconcentrated into a focus—still light in diffusion.

Almighty power, for the wisest purposes—for he does nothing in vain—separated, doubtless, the light to one part of the space, occupied by the solar system—perhaps to the centre—still, however, spread undoubtedly, judging from the testimony in the case, as well as from geological data, over a vast area like a nebulae, as before, yet more intense—being free caloric—that is being pure and uncombined—and then he distributed the opaque material, thus separated and divided into planets, into other parts of that same space, as he would have them located at various and appropriate distances from the separated central light, though as yet that light was not intense enough to give them visibility by its reflection from their opacity.

NEXT OCCURRENCE.

And now what occurred? Why, a revolution of the earth upon its axis, and probably of all the other planets, took place, which constituted the first "day" and "night," or "the evening and the morning" of the "first day;" since it is a conceded point among all philosophers, that light controls the movements of the

planetary worlds, and if *now*, it certainly must have done it *then*.

FIRST DAY A SINGLE REVOLUTION.

Now we hold that that revolution, which constituted the "first day," was a *single, literal revolution of the earth* upon its axis, as we assumed at the outset of our argument, and here we now come to the *supposed discrepancy* which is urged to exist between Geology and the authenticity and *strict literality* of Genesis ; which supposed discrepancy can, we believe, upon correct and *acknowledged scientific principles*, be fully shown to be *no discrepancy at all*.

THE EARTH'S CONDITION.

At this progressive stage of creation, what was the condition of our earth, provided that our premises and consequent deductions from them be correct, after the caloric was abstracted, and its chemical union dissolved by Almighty agency, and it was reduced from its aeriform condition ?

This question can be satisfactorily answered by imagining what it *would* be *now*, had its oceans, seas, lakes, fountains, and solid earth and rocks been all vaporized together by an amount of heat sufficiently intense to do it ; and then, had that caloric been abstracted by any means from the resulting vapor, and been again condensed from its gaseous condition. As the *water* of our globe far exceeds the amount of the

land, the material, when condensed from vapor, would have been precisely in that soft, plastic condition in which both Geology and Genesis shows it to have been at its origin.

OCEAN-ENWRAPPED GLOBE.

Water and the more solid particles of the material *must have been in a commingled and fluid mass*, but in the lapse of time, the heavier particles would have gradually settled down or gravitated towards the centre of that mass, by degrees have become solid there, and water being the lighter element, must have covered its entire surface to a considerable depth, and constituted one unbroken expanse of ocean.

HARMONY WITH GEOLOGY.

Instead of conflicting with true science, then, how beautifully geological is the Mosaic history; for, in this view of the subject, it harmonizes *precisely* with the whole testimony of geology.

Now in this condition of things, what must have been the effect of the "*aour*," or nebulous, unconcentrated light upon it, supposing it to have been as far removed from the centre of that light as it now is from the centre of our present sun?

INFERENCES BASED ON MATHEMATICS.

Let us make a calculation. Suppose that light was diffused over a space in bulk five or six million

times greater than that occupied by the sun as it now appears, which, it must be presumed, was the case, both from the facts of Geology and Genesis.

Then, as light—by a known and invariable law—diverges according to the squares of the distance in passing from a luminous body, its effect, according to this hypothesis, in producing the motions of the earth and the planets, *must* have been several million times *less intense* upon them than it is now. And what would have been the necessary consequence? Why, the movement of the earth upon its axis must have been *exceedingly slow and scarcely perceptible*.

FIRST DIURNAL ROTATION AN IMMENSE PERIOD.

Provided that light was several million times less intense upon the earth, as it must necessarily have been, and as light is most certainly God's agent to govern and control all its motions, then *must* it have been *several* million times longer in making its first rotation upon its axis, which constituted its "first day," than it is at present.

So, then, upon this hypothesis—an hypothesis actually and surely built upon the facts recorded in Genesis—the first rotation of the earth *was* just as many ages as the facts of Geology indicate, and *yet* was but a *single, literal* "evening and morning," which produced the "first day" of creation, and first geological day.

CHAPTER XXXIX.

FIRST GEOLOGICAL FORMATION.

WE now come naturally to the consideration of the geological formations of the "first day," or to what is technically denominated the "Cambrian or Graywake and the Silurian systems," which constituted the *Primary fossiliferous period*.

Was the condition of things, which our theory supposes to have existed during the first day of creation, congenial to the production of all those fossiliferous remains and geological phenomena which the primary period reveals, for if not, it cannot be sustained, however plausible, since, as we have assumed, the facts of Revelation and Geology must of necessity harmonize, emanating as they do from the same source or authorship? Let us examine the subject, and decide this question according to the evidence which may come before us.

FIRST PROPOSITION.

The organic remains of the primary fossiliferous period are marine animals and plants, which agree, so far, *entirely* with our view of the oceanic submersion of our globe during the first day.

SECOND PROPOSITION.

Those organic remains were the zoophytic tribes among the animals, and the flowerless plants and algæ, chiefly or entirely marine, among the vegetable classes. Now these, both animal and vegetable, were the very feeblest forms of life, but one slight progression from the condition of absolute inanimate substances.

Nearly the whole zoophytic tribes, in every variety of their organization, were exceedingly sluggish and almost inert, scarcely moving from the spot in which they were born during the whole period of their existence.

APPROPRIATE APPLICATION.

Now let us apply the test of these facts to our theory. Was there aught in our supposed primary condition of things calculated to sustain and foster such feeble life? Most certainly. For if animals and vegetables require caloric to sustain them, as no philosopher who understands the subject will deny, and if the vigor and energy of that life is, within certain limited boundaries, *in proportion* to the amount of caloric, as is equally undeniable, then is there a *definite reason* in our theory why the primary animal and vegetable organizations should have been so sluggish and of such a character.

PROPER CONDITION OF LIGHT FOR SUCH ORGANISMS.

The light being, according to our hypothesis, several million times less intense upon the globe than it is

now, would, of course, in amount, be precisely calculated to foster and sustain just such a feeble race of animals and vegetables as existed during the period of the first day. Indeed, had the light been any more intense than it then was, it is presumable that such organizations could not have existed exactly in the form they then existed, but must doubtless have perished, and that is very probably the reason why they became, in a great measure, extinct, when light became more intense or concentrated.

THIRD PROPOSITION.

There is abundant evidence, derived from the acute investigations of geologists, that the various organizations of this period, which constituted its fossiliferous petrifications, required a perfect quiescence of the waters in which they were generated. Some of the champions of the Mosaic history "maintain," we are aware, "that the fossiliferous rocks of the primary formation were not the result of slow deposition and consolidation," but might have been deposited by the deluge of Noah.

UNPHILOSOPHICAL SUPPOSITION.

This supposition is not, however, sustained by the facts in the case, for there must have been a violent and tumultuous action of the waters of the globe during that remarkable convulsion, "for the ocean must have flowed over the land in strong currents; and

when it retired, urged on as it was" by the resistless pressure of a gale, similar currents must have prevailed which must have entirely precluded the possibility of such a deposition of organic remains as Geology reveals, since they evidently required a quiescent location. They were, doubtless, deposited, then, during some more favorable period, long previous to the Noachian deluge.

QUIESCENCE ESSENTIAL.

Now it is worthy of consideration, whether our theory concerning the condition of the earth during the first day, would not be favorable in producing that quiescent state of the waters which must have existed throughout the long lapse of time required for the deposition of the fossiliferous rocks of the primary formation. We think it would, and for these reasons :

REASON FIRST.

The ocean could not have been agitated then as it is now, by the rapid rotation of the earth upon its axis every twenty-four hours, causing of necessity changes of temperature and windy currents.

REASON SECOND.

There was no revolution of the earth around the sun, because there was as yet *no* sun. We know that the earth now moves in its orbit at the mean rate of sixty-eight thousand miles in an hour. Being whirled

at such prodigious velocity through space, there must of necessity be produced some agitation among the fluids upon its surface, either by the rapidity of its motion, or the change of temperature and variable currents of wind consequent upon it.

REASON THIRD.

There were, undoubtedly, *no tides* then as there is now, since the influence of the moon in the production of those tides could not have been the same that it is at present, as it rotated not around the earth, and reflected not the light of the sun as it now does. There could then have been no oceanic currents produced by this cause..

REASON FOURTH.

But the most important reason of all, and one of itself sufficient to account for the perfect quiescent condition of the waters, at the geological period of the deposition of the fossiliferous rocks, is the fact, that there was *no atmosphere*, and of course *no wind*, and therefore *no currents* produced by wind.

OBJECTION.

But here, undoubtedly, will be urged a serious objection to our theory. It is this: If, as we have assumed, the earth might have been as many years as the primary geological formation in performing its first rota

of it—which must have been consequently turned for ages away from the light—must, the objector will strongly urge, have been *congealed* to an immense iceberg.

UNWARRANTABLE CONCLUSIONS FROM FALSE PREMISES.


But he must recollect that, in drawing this conclusion, he is reasoning from false premises, without the data of facts to sustain his argument. He reasons, for instance, from the *present* condition of our globe, which is unwarrantable.

Having ascertained that the oceans of the Arctic and Antarctic regions, when turned away from the sun for six months of the year, become congealed to icebergs, he concludes that the same must be the case with the earth under the circumstances which we have supposed to exist.

But he must recollect that there is no parallel between the two cases. There was then no rotation of the earth upon its axis in twenty-four hours, as now—there was no revolution yearly around the sun to produce a variation of temperature from heat to cold, or from cold to heat—there was no atmosphere to lower the temperature by currents of wind, *or to carry off the caloric by evaporation.*

LESS DENSE.

Besides having been recently reduced to its plastic condition, it was less dense than it is now, and there-



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CHAPTER XL.

OUR REASONS FOR MINUTE INVESTIGATION.

WE have dwelt minutely upon the fossiliferous formations of the primary period, because *here*, mainly, the Mosaic account of creation has been supposed to conflict with the facts of Geology. Having done so, there will be no necessity for dwelling, with such minuteness, upon the history of the remaining days; we shall, therefore, consider them much more briefly.

ATMOSPHERE CREATED.

The next step in the process of creation was the production, by the Almighty, of the expanse, or atmosphere, which surrounds the earth.

ITS EFFECTS.

This must have vastly changed the previous condition of the globe. There was now a medium for evaporation, and a new element, upon which the vapors could be borne and the clouds formed, which existed not during the first day.

The waters of the globe must now have become more agitated than before; the temperature of the atmosphere, being necessarily variable, must have begun

to produce currents of wind ; these must have disturbed the former quiescence of the water ; and the consequence must have been the extinction of many of the previous forms of life, which *accords exactly* with the discovered facts of Geology.

NEW ORGANISMS CREATED.

But the places of these extinguished existences were supplied by the creation of new orders of being, adapted to the changed condition of the globe.

AN IMPORTANT RESULT.

Another important result was produced by the creation of this new element. As, according to computation, the atmosphere extends forty-five miles above the earth, it became a medium to sustain a vast amount of vapor, which was now to be separated from the waters of the ocean, so that their amount might thereby be lessened, and the dry land the sooner appear.

SECOND DAY.

The period of this creation constituted the evening and morning of the "*second day*," which was a literal revolution of the earth upon its axis, but yet another immense period of time—one as long as Geology indicates ; for not yet was the light gathered into the focal intensity of a sun, although that light might have been much more concentrated than during the first day, which the fossiliferous formations of this period

indicate ; and it would, therefore, have been shorter than the first day, though very long.

THIRD DAY.

On the third day, the waters of the globe were collected together into separated oceans, seas, and lakes, and the dry land was made to appear, very probably by the upheaving of its submerged surface into heights or mountains, by the action of subterranean fires or chemical agencies, which had been generated during the immense period of the two previous days, leaving corresponding cavities for the water. And now grass, and trees, and fruit, were produced ; but the light was not yet formed into a sun, although the geological formations of this period indicate a still greater condensation than heretofore.

THE CAVILLER SCOFFS AT FACTS

Now the caviller may affect to scoff at the gradual condensation of light, but if he does he scoffs also at some of the well attested discoveries of astronomy. Sir William Herschel draws the conclusion, from certain appearances in the heavens, that the detached masses of *nebulæ* are, in some cases, assuming very slowly, but surely, a more and more globular and concentrated form, as though new suns and systems were in the process of formation.

IMPORTANT CREATIONS OF THE FOURTH DAY.

On the fourth day God completely condensed the light into the focal intensity of our present sun.

Then, for the first time, the moon, and Venus, and Mars, and Jupiter, and Saturn, and all the other planets of the solar system, which had before been invisible, on account of the feebleness of the light, flashed out into visibility, as though they had for the first time been created, and commenced their diurnal and annual revolutions, which have since been maintained with such perfect and undeviating regularity, in accordance with those physical laws which were then established by the Almighty.

Having thus passed through with our examination of the progress of the first four days of creation, and considered the effect of a gradual condensation of light into the focal intensity of our sun, we are willing to contrast our views upon this subject with the various and often conflicting opinions of the whole infidel and sceptical world; for we think that any unprejudiced mind must conclude that upon this hypothesis *the philosophy* of Moses was quite as sound and rational as that of a Newton, a Locke, or any other sage that has existed or written since his day.

CREATIONS OF THE FIFTH DAY,

And now, as the earth had previously been prepared for it, and as the light had become sufficiently intense to produce vegetation, God created upon the fifth day all the various races of beasts, birds, and fishes which now exist upon the globe, and which, according to geology, took the place of many of those modes of

organic life which had previously existed, and which had one after another become extinct, as the several successive changes occurred in the progressive organization of the earth, which extinguished forms of life constituted the remainder of those fossiliferous depositions existing in the rocky strata of the globe not heretofore considered in our argument.

THE CROWNING WORK.

To crown the whole amazing work of creation, on the sixth day God completed his work by the creation of Man, in his own image, whom he endowed with rational faculties, and constituted lord of this new and beautiful province of his universal empire.

HARMONY OF GENESIS AND GEOLOGY PROVEN.


We have extended our argument thus far, to show that Genesis may be both authentic and literal, and yet most perfectly harmonize with all the known facts of geology, and we must here express our deep and unwavering conviction, that in no other way can they possibly be so harmonized.

RECAPITULATION.

One thing is apparent from our investigation of this subject, which we shall notice before closing. Gradual progression was the order of creation, and seems to be the established order of all God's works. He has thus shown us that he accomplishes his purposes *by means*, and that in the production of every event there is chained

together a certain train of dependent antecedents and consequents.

As we have seen in creation, by a certain progressive process of six days, the Almighty brought into existence that part of the material universe with which we are conversant. The Spirit of God moved with energizing power upon the nebulous masses of the sky. At the command of the Eternal, light was poured upon the formless "void" of the "deep." The dark, chaotic mass of material substance was separated to its appointed destination. From the basis of that mass of matter there arose, then, by degrees, into beauty, order and magnificent vastness this globe and her sister planets. The nether firmament was spread out between the clouds and the deep, and the buoyant atmosphere was formed to sustain the floating vapors. Visibility was given to the dry land, and the hills, and valleys, and landscapes were covered with blossoms, and fruits, and vegetation. The sun was, on the fourth day, collected together into one mass of burning glory, and hung out like an immense ocean of fire in the vault of the sky. The moon and the stars were located around it, so as to reflect its radiance with diminished intensity. Streamlets, rivers, and oceans were filled with living substances. Flocks and herds were "scattered over a thousand hills," and finally, to crown the whole, *Man*, the almost angelic proprietor of this uncursed, beauteous, green earth, was introduced into the fragrant groves and arbors of Eden.



CHAPTER XLI.

A UNIVERSAL DELUGE.

WITHOUT any unnecessary preliminaries, we, shall, in opposition to the opinions and arguments of sceptics, assume the position—that the account of the deluge, contained in the Bible, is both *authentic* and *strictly literal*—that, in the sublime and graphic language of inspiration, “the windows of Heaven were opened, and the fountains of the great deep were actually “broken up”—that it actually rained “forty days and forty nights”—that the deluge, actually, so prevailed over the earth, as to overflow and overtop the “highest mountains” of the earth “fifteen fathoms,” and that, by the grand and awful catastrophe, every form of animated existence upon the Globe was actually destroyed—actually swallowed up in the devouring vortex of the mighty flood—except those, who floated safely in the ark, over the surface of the ocean enwrapped earth.

For the sake of perspicuity, I shall arrange my argument and defence of this position, under the following general heads :

FIRST PROPOSITION.

A general deluge is proven by the almost universal traditionary testimony in favor of such an event, which prevails in the archives and mythological fables of all heathen and barbarous nations.

SECOND PROPOSITION.

There must have been an *external* concussion, that dragged the earth out of its original position *twenty three and a half* degrees, which external concussion, must have caused the deluge.

THIRD PROPOSITION.

There is abundant proof in Geology that some violent deluge of waters, similar to that described in the Mosaic history, has once prevailed over the whole earth.

FOURTH PROPOSITION.

In harmony with every physical fact and law, reason unites her important testimony with science, to establish the undoubted certainty of such an event as a universal deluge.

TESTIMONY OF MYTHOLOGY.

Among the Romans, Grecians, Persians, Babylonians, Egyptians and Scythians, in India, China, and Hindostan—among the aboriginal Iroquois, Mexicans, Brazil-

ians, Peruvians and other aboriginal tribes of America, and, indeed, in the archives of almost every ancient nation on the globe are to be found accounts, more or less mingled with fabulous legends, of a **UNIVERSAL DELUGE**, and there could not have been such a general coincidence, without any motive for collusion, unless such an event once occurred.

DELUGE CAUSED BY EXTERNAL CONCUSSION.

There are several very important reasons, which impel us to come to the conclusion, that the terrible convulsion of the deluge was caused by the concussion of an external cause which changed the polarity of the earth.

1st. We cannot conceive that the *original* position of the poles or axis of the earth could have been otherwise than at *right angles* with the plane of the *ecliptic*. This we should suppose would be its *natural* position.

2d. If that had been the case, there would have been equal day and equal night the world over and the year round, while the earth remained in that position.

3d. If there was originally equal day and equal night, there would not have been such variations of temperature as there are now. Of course there would not, in consequence, have been the same causes of *disease*, which now prevail, owing to the variable temperature consequent upon the inclination of the poles, and

human life would have been very much prolonged, as *was* the case in the antediluvian era.

4th. There is no evidence on record that it *ever rained before the deluge*. In consequence of there being no storms, the immense dews plentifully moistened the earth, and for that very reason the rainbow never appeared until after the flood, and was then stamped on the cloud for the first time, as a token, by the Eternal.

5th. The reason why there was no rain, as now, was because there was no inclination of the axis, and therefore no extreme of summer at one pole and winter at the other, which produces that variation of temperature that generates storms.

6th. Because there exist just such external forces as would produce such a concussion and change of poles. Comets, in passing by our earth toward the sun, sweep onward sometimes at a velocity past conception. Now, such an one, striking the earth at one of its poles, would drag it away from its original position. Besides, it would have the effect to drive the *solid* earth into the yielding element, and bring the currents of the oceans in tumultuous torrents over the land.

7th. There is every evidence in Geology that the earth has, at some period of its existence, been thus driven through the yielding oceans from the south to the north, and that the bulk of the land was once at the *south* pole instead of the north, and therefore that the bulk of the ocean was at the north instead of the

south, as now. Immense auricularias are found in coal beds, with standing stumps, between forty and fifty degrees of north latitude, and *we know* that those auricularias are a *tropical* production.

The *drift*, which was the effect of a great deluge, instead of glacio-aqueous action, shows conclusively, *on both continents*, that the course of the tremendous current that deposited it was *from northeast to southwest*.

The heavier boulders and larger stones of this drift-deposit are found in high northern latitudes, and grow less and less the further south you go, which proves that the most weighty part of this drift was deposited *first* by the force of gravitation, and the lighter portion was carried on further by the current.

8th. In the book of Enoch, which Jude quotes, and which, after having been lost for centuries, was found in Ethiopia, and deposited in the Bodleian Library, at Oxford, there is this remarkable prophecy: speaking of the earth, this prophecy declares that, "ITS SUBSTANCE SHALL SINK INTO THE ABYSS, *and a great destruction shall take place.*" The earth being driven by this terrible concussion—that is, "its substance," the solid part of it—the "fountains of the great deep were broken up" *by it*, and the currents of the northern oceans were brought over the land, the earth was submerged in the "abyss," so that the waters rose "fifteen cubits above the tops of the highest mountains, the atmosphere was filled with vapor by this terrible com-

motion of elements, and, in consequence, it actually rained forty days and forty nights, incessantly. Thus was that deluge produced which sceptics have sneered at so ignorantly.

Of course, in a view of this interesting subject as condensed as the one we have given, we could but just afford it a passing glance. There are a multitude of other facts and arguments, which would all go to strengthen our position, and prove conclusively a deluge such as we have described. But sufficient has been said to convince one not biased by prejudice, and one who is thus biased we could not convince, if we piled argument upon argument, and fact upon fact, as high as Chimborazo. ✓

W. G.

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